TM11-811

WAR DEPARTMENT TECHNICAL MANUAL

RADIO TRANSMITTER BC-445-J

AND

REMOTE CONTROL UNIT RM-45-A

RESTRICTED. DISSEMINATION OF RESTRICTED MATTER. No person is entitled solely by virtue of his grade or position to knowledge or possession of classified matter. Such matter is entrusted only to those individuals whose official duties require such knowledge or possession. (See also paragraph 23b, AR 380–5, 15 March 1944.)

WAR DEPARTMENT · *8 JANUARY 1945*

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WAR DEPARTMENT
Washington 25, D. C., 8 January 1945

TM 11-811, Radio Transmitter BC-446-J and Remote Control Unit RM-45-A, is published for the information and guidance of all concerned.

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Washington 25, D. C., 8 January 1945

RADIO TRANSMITTER BC-446-J
and
REMOTE CONTROL UNIT RM-45A

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WARNING!

The voltages in this equipment are dangerous to life. NEVER depend upon action of door interlock switches for safety. Disconnect all a-c line voltages before making repairs or adjustments within the cabinet. Be sure that the transmitter is turned OFF before making any antenna adjustment or climbing any of the antenna towers.

DESTRUCTION NOTICE

DESTROY EVERYTHING

WHY — To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN — When ordered by your commander.

HOW — 1. *Smash* — Use sledges, axes, hand-axes, pick-axes, crow-bars, heavy tools.

2. *Cut* — Use axes, hand-axes, machetes.

3. *Burn* — Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. *Explosives* — Use firearms, grenades, TNT.

5. *Disposal* — Bury in slit trenches, fox holes, other holes. Throw into streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT — 1. *Smash* — Crystals, tubes, capacitors, insulators, etc.

2. *Cut* — All terminal wires and wire wherever exposed, all cables in several places.

3. *Burn* — Everything.

4. *Bend or break* — Cabinets, chassis, cases, covers, handles.

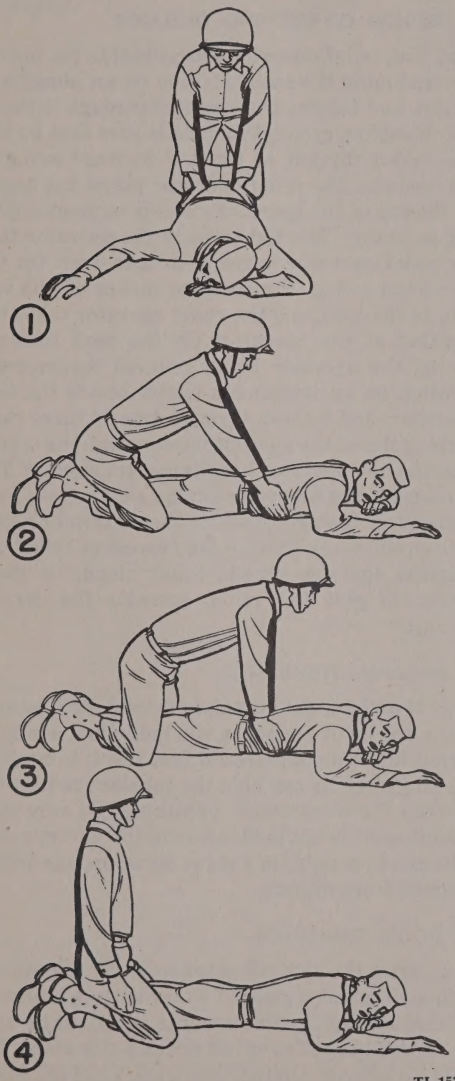
5. *Bury or scatter* — Everything.

DESTROY EVERYTHING

FIRST AID FOR ELECTRIC SHOCK

I. RESCUE

a. In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other non-conductor to free the victim. An ax may be used to cut the high voltage wire; however, be watchful of electric flashes which may result disastrously.



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II. SYMPTOMS

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breathing center recovers after a while and normal breathing is resumed, provided that a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a very few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must still be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

III. TREATMENT

a. Start artificial respiration immediately. At the same time send for a doctor, if assistance is available. Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only*, remove the victim to another location, but no farther than is necessary for safety. If the new location is more than a few feet away, artificial respiration should be given while the victim is being moved. During transportation, other methods of resuscitation may be used, if the method of transportation prohibits the use of the Shaeffer prone pressure method. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth to mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

b. Lay the victim in a prone position, one arm extended directly overhead, and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing (figs. ① and ②).

c. Open the victim's mouth and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open, with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

d. If an assistant is available during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm, by applying blankets or other covering, or by applying hot rocks or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also be ever watchful to see that the victim does not swallow his tongue. He should continually wipe from the victim's mouth any frothy mucous or saliva that may collect and interfere with respiration.

e. The resuscitating operator should straddle the victim's thighs, or one leg, in such a manner that:

(1) The operator's arms and thighs will be vertical while applying pressure on the small of the victim's back (fig. ③).
(2) The operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib.
(3) The heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim (fig. ①).
(4) The operator's elbows are straight and locked.

f. The resuscitation procedure is as follows:

(1) Exert downward pressure, not exceeding 60 pounds, for one second.
(2) Swing back, suddenly releasing pressure, and sit on the heels (fig. ④).
(3) After two seconds' rest, swing forward again positioning the hands, and apply pressure for another second (figs. ① and ③).

g. The forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion, which requires one second. The release and backward swing require one second. The addition of the two second rest makes a total of four seconds for a complete cycle. Until the operator is thoroughly familiar with the correct cadence of the cycle, he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Example: one thousand and one, one thousand and two, one thousand and three, one thousand and four, etc. This method of counting insures accurate timing. The exact frequency of the operating cycle of resuscitation is of utmost importance.

h. Artificial respiration should be continued without interruption until the victim regains normal breathing or until pronounced dead by a medical officer. It may be necessary to continue resuscitation for several hours. For this reason relief operators should be used if available.

IV. METHOD OF RELIEVING OPERATOR

a. The relief operator kneels beside the operator, assuming the same position on an imaginary victim, and follows the operator through three or four complete cycles. When he is sure that he has the correct rhythm, on the next forward swing of the operator the relief operator places his hands on the top of the operator's hands without applying pressure. This indicates to the operator that the relief operator is ready to take over. On the backward swing, the operator moves off the victim, to the side, and the relief operator takes the position of the operator. On the next forward swing, the operator being relieved assumes the position on an imaginary victim beside the new operator, and follows through two or three complete cycles of the new operator, or until he is sure that the new operator has the correct rhythm. The operator being relieved remains alert to take over instantly if the new operator should falter or hesitate on the cycle. During the process of relief, the original operator should count aloud, by thousands, to give the relief operator the correct timing.

V. INHALANT STIMULANTS

a. If an inhalant stimulant is used, such as aromatic spirits of ammonia, the individual administering the stimulant should first test it himself to see how close he can hold the inhalant to his own nostrils for comfortable breathing. Be sure that the inhalant is not held closer to the victim's nostrils and then only for a short duration, one or two seconds every minute.

VI. LIQUID STIMULANTS

a. After the victim has regained consciousness, he may be given a glass of water with ½ teaspoon of aromatic spirits of ammonia added, or he may be offered hot coffee or hot tea as a stimulant. DO NOT GIVE AN UNCONSCIOUS VICTIM ANY LIQUIDS.

VII. CAUTION

a. After the victim revives, keep him lying quietly. Do not allow him to get up and walk even though he may feel that he is strong enough. Any injury which a person might have received, including electric shock, may bring about a condition of shock or fainting. This condition should be guarded against at all times. Shock is present if the victim is pale and has a cold sweat. His pulse is weak and rapid and his breathing is short and gasping.

b. Keep the victim lying flat on his back, with his head lower than the rest of his body, and his hips elevated. Be sure that no tight clothing restricts the free circulation of blood or hinders natural breathing. Keep him warm and quiet.

c. A resuscitated victim may suddenly stop breathing and require additional artificial respiration. For this reason, he must be carefully watched. NEVER LEAVE A RESUSCITATED PERSON ALONE UNTIL IT IS *CERTAIN* THAT HE IS FULLY CONSCIOUS AND BREATHING NORMALLY.

Figure 1. Radio Transmitter BC-446-J, Remote Control Unit RM-45-A, and Microphone T-32.

Section I

DESCRIPTION

Symbols of parts shown on illustrations throughout this technical manual are interpreted on either figure 35 or figure 48 or in paragraph 80.

1. GENERAL

a. Components. (1) Radio Transmitter BC-446-J (fig. 1) is a 100 watt, intermediate frequency, amplitude-modulated aural radio range transmitter. It is comprised of all the components, except two crystals, the power supply, and the antenna system, for either crossed loop or Adcock tower range antenna installations. Provision is made for control of the transmitter and throw-over to voice broadcast from a remote position.

(2) Remote Control Unit RM-45-A, used with one Microphone T-32 and two pairs of telephone lines connected to the transmitter, provides positive control of the transmitter for start, stop, and throw-over to voice broadcast from a remote position.

b. Function of Radio Range. (1) Radio is an important aid in navigation. Of the various types of directive radio beacons developed for aircraft use, the radio range equisignal beacon system has had by far the widest application. The radio range station in common use consists of a transmitter which is located on the ground and uses two crossed-loop or Adcock antennas which are alternately excited. The directional characteristics of the crossed antennas are shown in figure 2. Note that in certain directions the signals from the two antennas are of equal strength (equisignal line).

(2) The two antennas send out complementary A-N signals so that the signal heard along the equisignal line is a continuous tone, while at points to the side of this equisignal course either an A or N signal is received, depending on the quadrant from which it is heard. In figure 2, the A signal is heard in quadrants 2 and 4, and the N signal in quadrants 1 and 3.

(3) The A-N sequence is interrupted several times per minute and identifying signals are transmitted so that the pilot can identify the radio range in which he is flying. These radio range stations are about 200 miles apart, and their radiation patterns are arranged to fit into one another; figure 3 shows typical airways in the United States. An airplane leaving one zone is presumably able to pick up the next beacon and proceed from airport to airport by flying on the equisignal course. The aeronautical map carried by the pilot helps him to determine at all times whether he is flying toward or away from the beacon.

c. Course Alignment. The various courses of each radio range can be aligned to the actual routes followed in several ways. In the system used with Radio Transmitter BC-446-J, unequal power is supplied to the two antenna systems. The effect of this is to vary the angle between the equisignal lines. Furthermore, the entire pattern may be rotated in azimuth by using a goniometer arrangement. This obviates the necessity of moving the antennas when a change or correction in course is desired.

d. Voice Transmission. In addition to the A-N and identification signals, the transmitter can also be used as a radio telephone, so that weather reports and other important matter can be received by all aircraft in the neighborhood. The same receiving equipment is used.

2. LIST OF COMPONENTS (Fig. 1)

a. Weights and Dimensions. Dimensions given are exclusive of external knobs, insulators, and connectors. For weight and dimensions of packing cases, see paragraph 7.

Quan.	Component	Net Weight (lb)	Height (in.)	Depth (in.)	Width (in.)
1	Radio Transmitter BC-466-J	1050	77	30	40
1	Remote Control Unit RM-45-A	28	$6\frac{31}{32}$	$7\frac{13}{16}$	19
2	Microphones T-32, each complete with 6 ft cord and plug.	3.1	12	6	5

b. Running Spares. A list of running spares is given in paragraph 79.

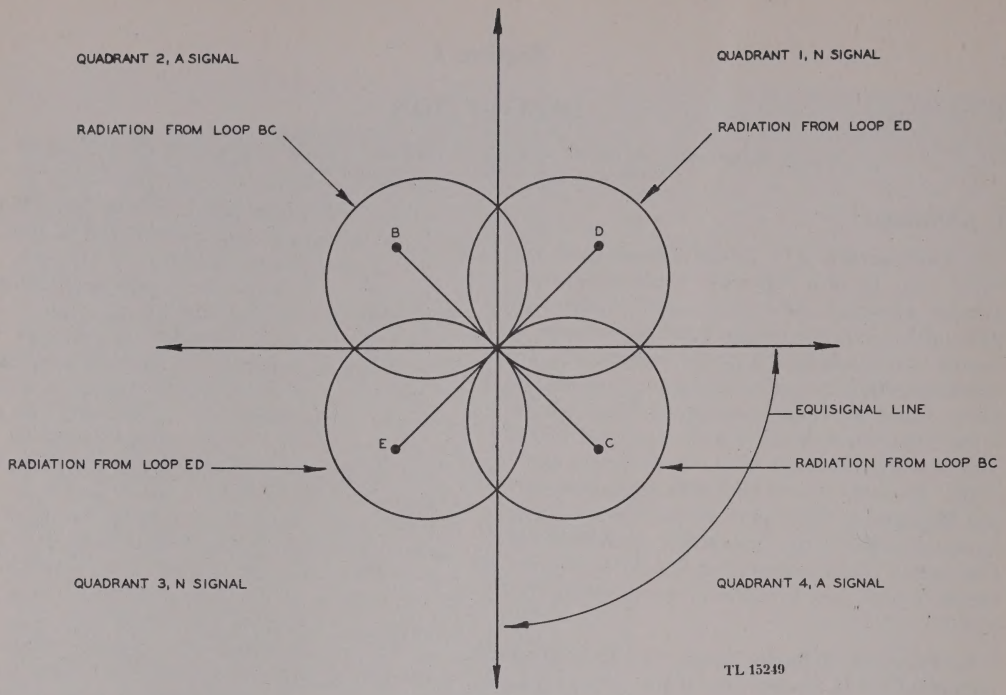


Figure 2. Radio range pattern.

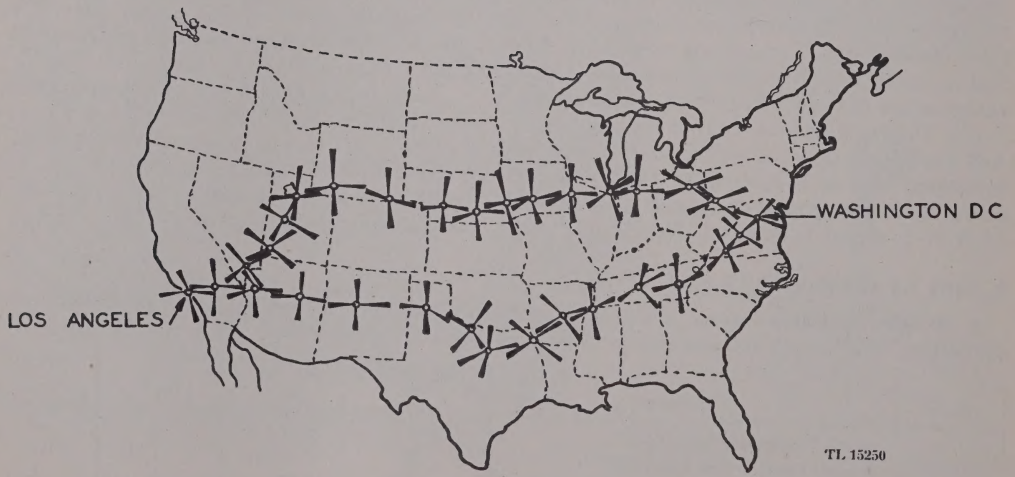


Figure 3. Typical airways in the United States.

3. MATERIAL REQUIRED BUT NOT FURNISHED

A complete installation requires the following material not furnished under this contract:

a. A source of power, either 115 or 230 volt, 60 cycle, single phase.

b. An antenna system of the crossed loop type or like the Adcock tower system with transmission lines and coupling devices.

c. A ground connection.

d. Housing for the transmitter.

e. Two quartz crystals of proper frequency, one each in Holder FT-164.

f. Two pairs of telephone cables.

4. DESCRIPTION OF RADIO TRANSMITTER BC-446-J

a. The transmitter (figs. 4 and 5) is constructed with an internal steel framework upon which the various parts are assembled. The transmitter is divided into four sections or shelves. The bottom shelf contains the fuse and relay panel, power relay panel, the blower unit, voltage stabilizer VR1, transformer T1, and reactor X4. The three rectifier chassis, keyer, and switches are located on the second shelf. The third shelf is comprised of the meter and control unit, the a-f unit, and the r-f unit. The goniometer L5, the right and left goniometer tuning units, and the right and left meter rectifiers are located on the top shelf. The transmitter is shielded at the sides and rear by wrinkle-finish metal panels, and at the bottom by metal skirts. The side bottom skirts are slotted to permit the power and control lines to pass through.

b. The front of the transmitter is black wrinkle-finished. All controls normally used in operation and in tuning the transmitter are at the front. Two doors with plexiglas windows extend the length of three shelves, and through them the operator can observe the action of the link circuit relay and the keyer. The doors permit the operator quickly to replace burned-out fuses, check the operation of all relays, and replace tubes.

c. The goniometer occupies the center of the top shelf. Above the goniometer there is a hatch cover with plexiglas windows through which the right and left meter rectifier tubes can be observed. This hatch cover is hinged at the top.

d. The top panel of the transmitter holds the outlet air filter, and in addition four feed-through cup insulators and two ground studs for connecting the load.

5. DESCRIPTION OF REMOTE CONTROL UNIT RM-45-A

a. The remote control unit (figs. 6 and 7) is housed in a black wrinkle-finish, metal case. It is designed to fit a 19 inch standard relay rack. The top and rear shield are in one piece. This shield is fastened by two wing nuts at the rear of the unit. The removal of this shield will provide ready access to relay E1R, tube V1R, capacitors C1R and C2R, MICROPHONE JACK J1R, MODULATION LEVEL control R2R, AUDIO LINE LEVEL meter M1R, RANGE ON-OFF switch and associated pilot, VOICE pilot, A.C. LINE ON-OFF switch and associated pilot, AUDIO LINE LEVEL meter, MODULATION LEVEL control, and MICROPHONE JACK. At the rear of the unit there is a terminal strip of five terminals, a fuse, and an a-c line receptacle. The fuse is of the extractor post type. The a-c line plug is a midget twist-lock type.

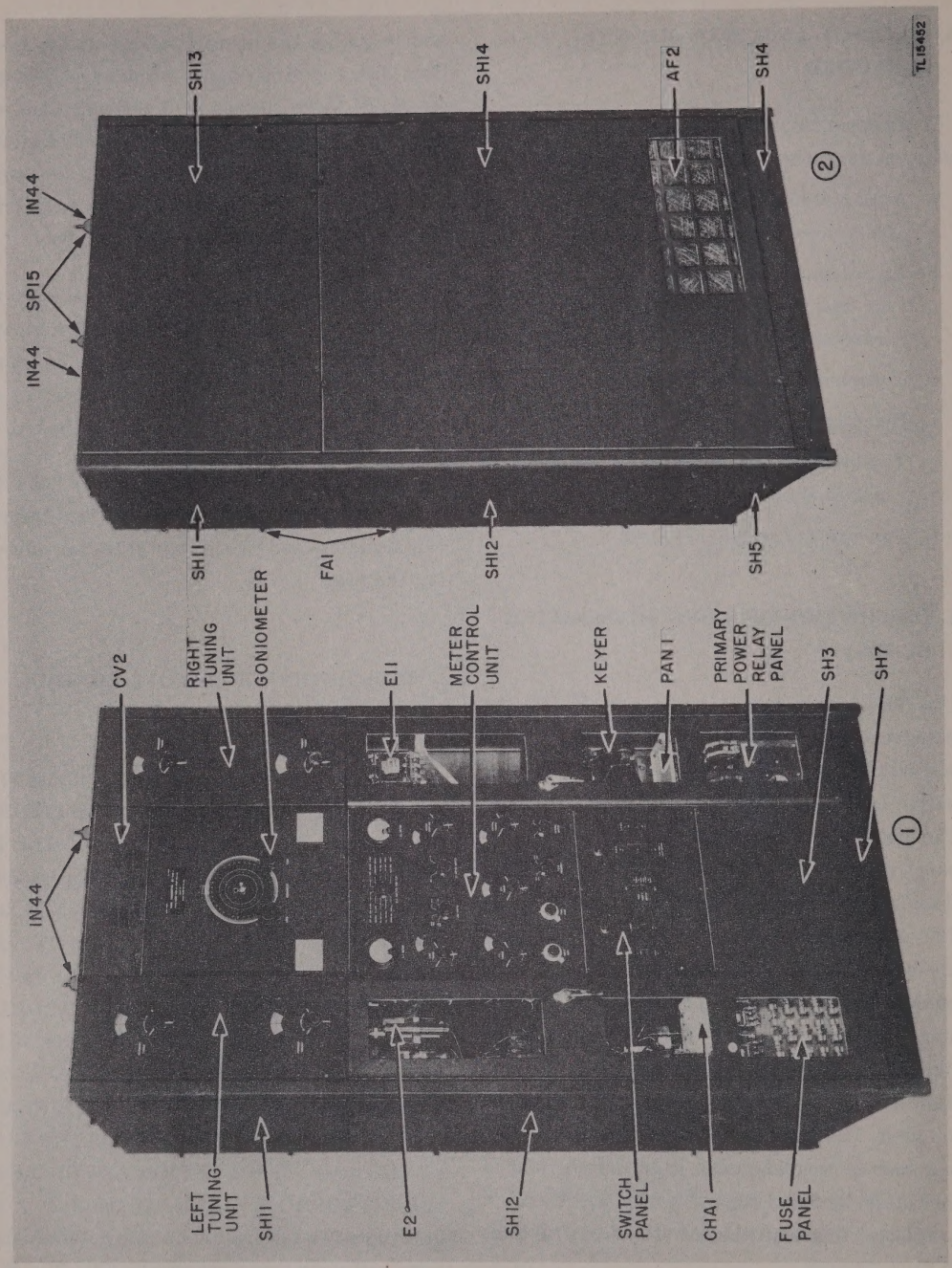


Figure 4. Radio Transmitter BC-446-J: (1) Front and left side view; (2) Rear and right side view.

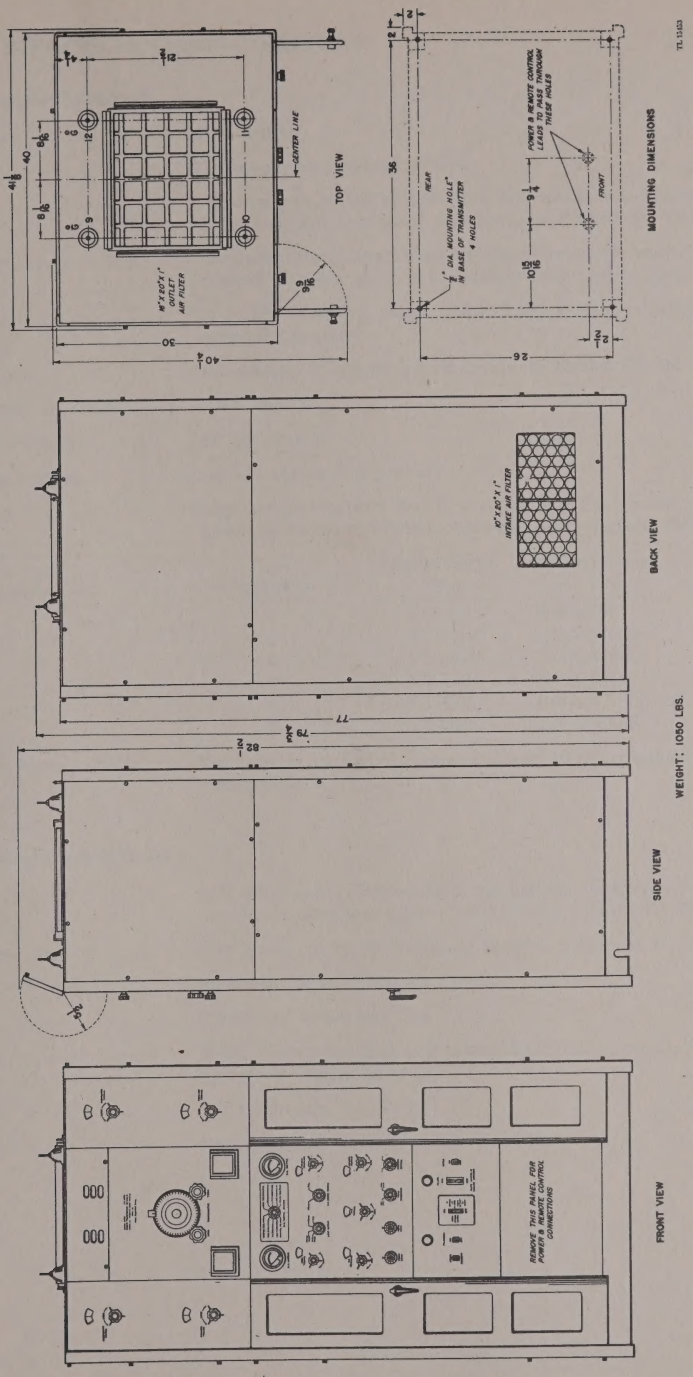


Figure 5. Radio Transmitter BC-446-J, outline drawing.

6. SUMMARY OF ELECTRICAL CHARACTERISTICS

a. Radio Transmitter BC-446-J.

(1) Frequency range ..... 200 to 400 kc

(2) Output power ..... 100 watt carrier, modulated 100%

(3) Type of signal ..... A-N aural range, 500 or 1,020 cps, 5/8 minute standard radio range keying cycle, standard long letter identifications, PRESS TO TALK voice broadcast

(4) Antenna system ..... Two crossed loops, approximately 450 microhenries and 11 ohms at 300 kc, or four 70 ohm concentric transmission lines feeding four towers

(5) Input power ..... 115 or 230 v, 60 cps, single phase, 1,350 va without tube heaters, 1,750 va with tube heaters

(6) Frequency control ..... Fundamental frequency quartz crystal in Holder FT-164

(7) Ambient temperature range..... −15 C to +50 C

(8) Course setting method ..... 360° goniometer

(9) Course shifting method ..... L pad in goniometer primary

(10) Voice broadcast ..... Range antenna system used by exciting both goniometer primaries 90° out of phase by means of a switch-over relay operated from the remote control unit

(11) Vacuum tube complement .....

Quantity	Signal Corps Type	Commercial Type	Joint Army-Navy Type
5	VT-100	RMA-807	JAN-807
2	VT-42-A	RMA-872-A	JAN-872 A
2	VT-46-A	RMA-866-A	JAN-866A/866
4	VT-143	RMA-805	JAN-805
4	VT-139	RMA-VR-150-30	JAN-0D3/VR-150
3	VT-90-A	RMA-GT/G	JAN-6H6/G

(12) Communication range in miles .... The beam is effective for approximately 50 miles, subject, of course, to local conditions

b. Remote Control Unit RM-45-A.

(1) Function ..... A-N aural range, 500 or 1,020 cps, 5/8 minute standard radio range keying cycle, standard long letter identifications, PRESS TO TALK voice broadcast

(2) Telephone lines required ..... Two pairs, maximum resistance equal to 6 miles of No. 19 wire

(3) Line current and voltage ..... Maximum 35 v, 35 ma, d-c

(4) Audio level ..... 6 milliwatt to 600 ohm line

(5) Microphone ..... T-32; microphone jack will take Plug PL-54 or equal; Signal Corps Microphone T-17 may be used

(6) Power supply ..... 115 v, 60 cycle, a-c, 40 va

(7) Vacuum tube ..... 1 tube VT-145, RMA type 5Z3, JAN-5Z3

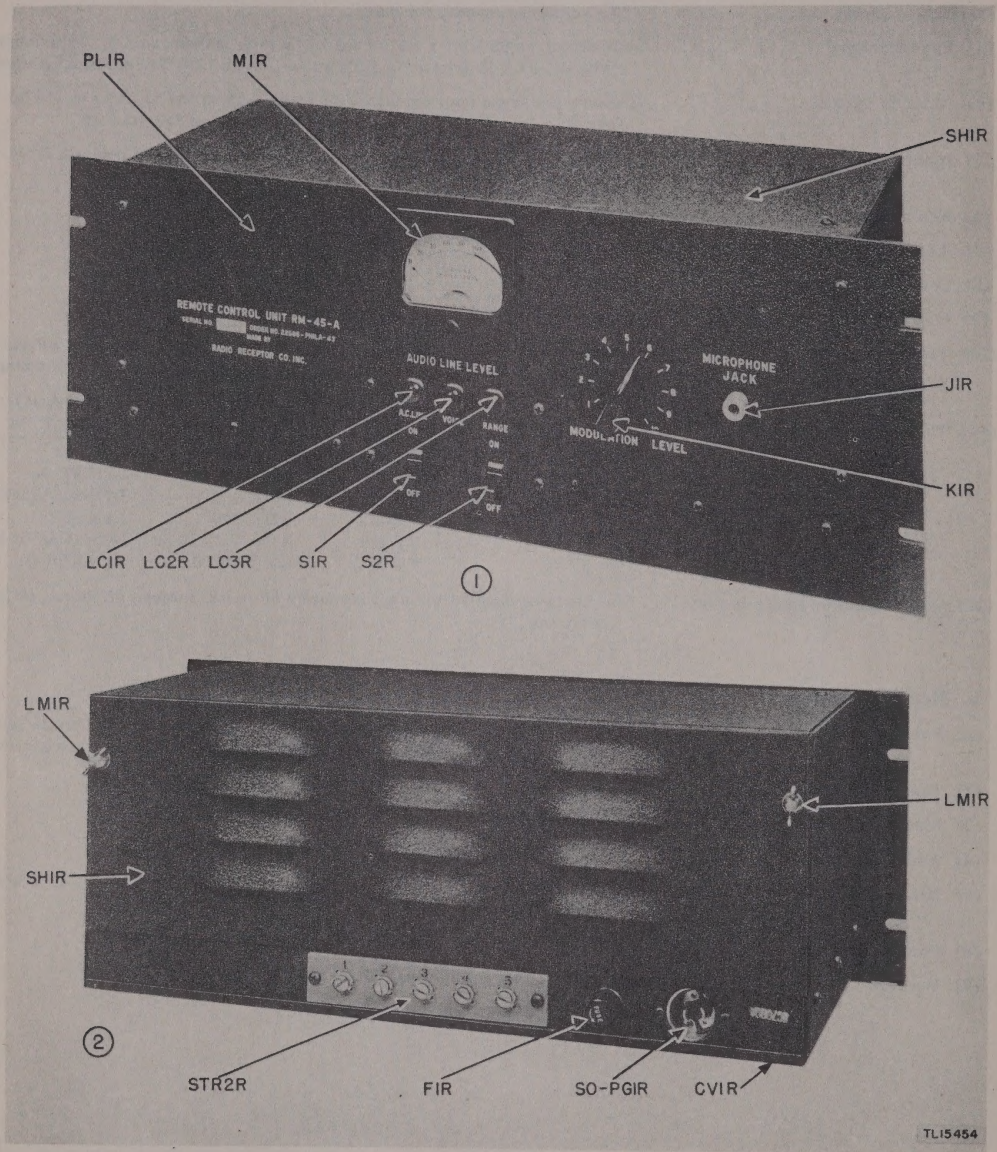


Figure 6. Remote Control Unit RM-45-A: ① Front view; ② Rear view.

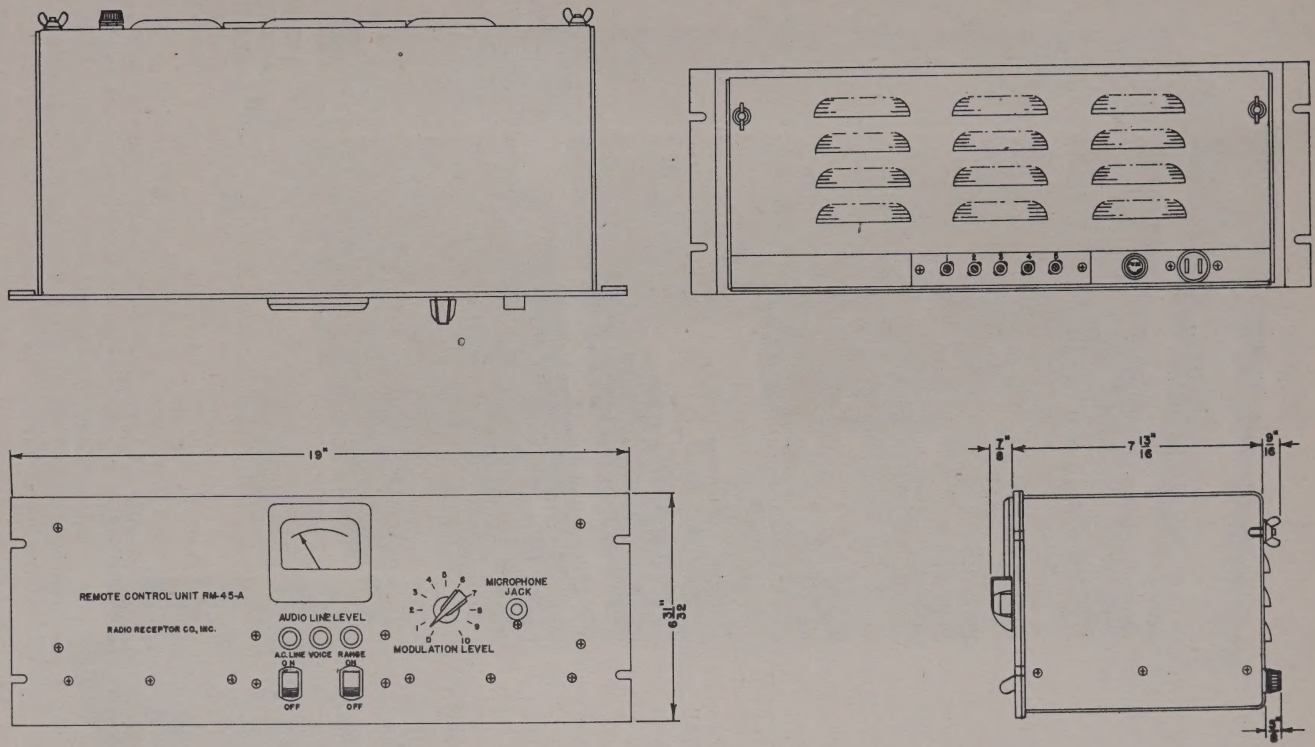


Figure 7. Remote Control Unit RM-45-A, outline drawing.

Figure 7

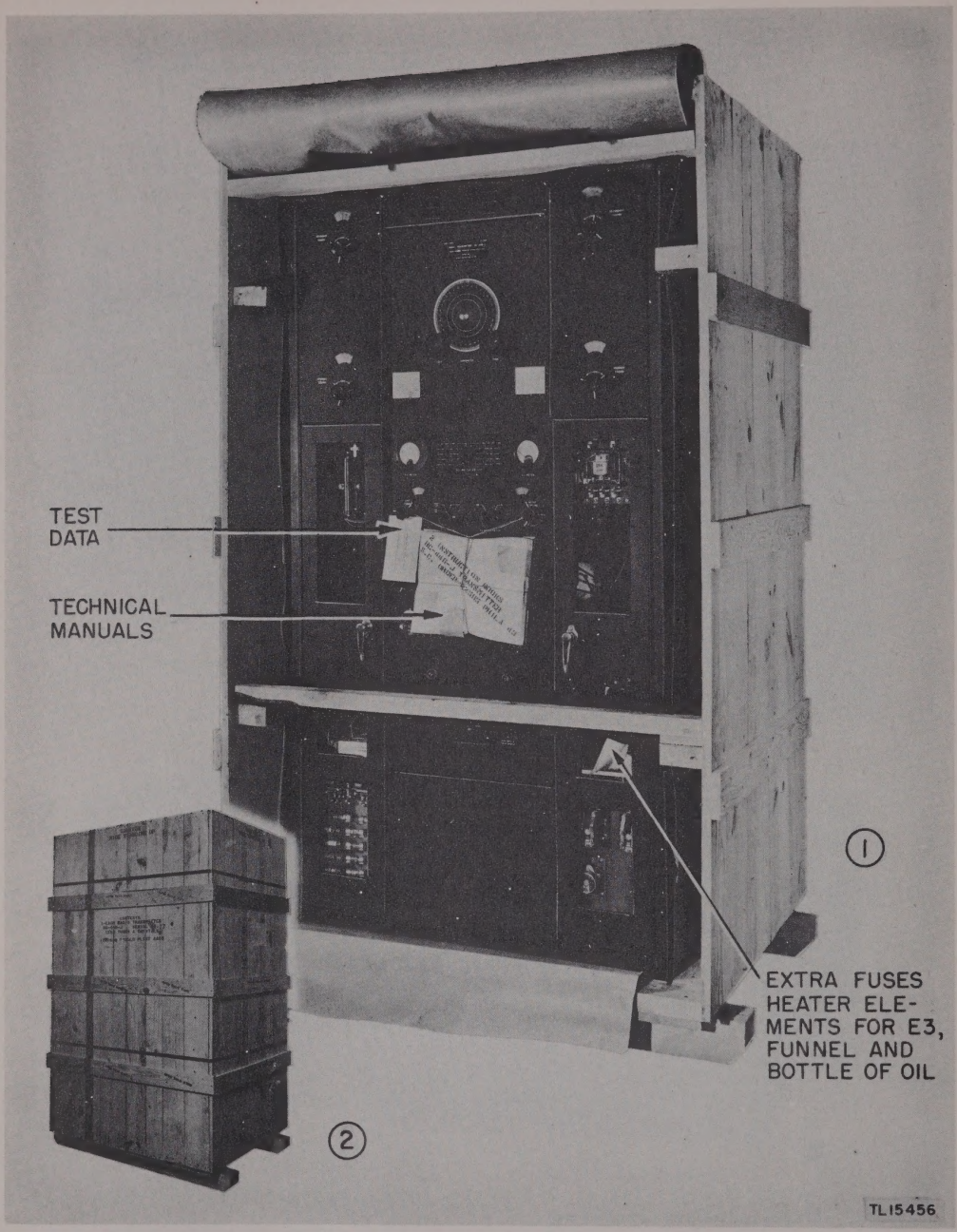


Figure 8. Packing case 1: (1) Open; (2) Closed.

Section II

INSTALLATION AND OPERATION

7. CONTENTS OF SHIPMENT

a. Case 1 (Fig. 8). Contains one Radio Transmitter BC-446-J complete with fuses and pilot lamps, less tubes and crystals. (Gross weight 1,475 lb)

b. Case 2 (Fig. 9). Contains two sets of vacuum tubes for Radio Transmitter BC-446-J. (Gross weight 80 lb)

c. Case 3 (Fig. 10). Contains one set of spare parts for Radio Transmitter BC-446-J. (Gross weight 115 lb)

d. Case 4 (Fig. 11). Contains one Remote Control Unit RM-45-A, complete with tube, fuse, and pilot lamps; one set of spare parts for Remote Control Unit RM-45-A; two Microphones T-32, complete with cords and plugs. (Gross weight 95 lb)

8. UNPACKING AND CHECKING

CAUTION.—Do not use a crowbar when opening cases. It may damage the equipment. Use a nail-puller instead.

a. Open cases 2, 3, and 4. Check the contents against the enclosed packing list. Examine each part for damage.

b. Locate case 1 in the exact desired position. The side marked front is the actual front of the transmitter. In most military applications it is desirable to leave the transmitter on its skids to facilitate removal. Remove the top and sides of packing case, using a nail-puller.

c. To remove the skid, because of a low ceiling or for better appearance, remove skirts SH4, SH5, SH6, SH7 (fig. 4) at the bottom of the transmitter. Loosen the bolts which fasten the transmitter to the skid. Tilt the transmitter carefully, and insert a block under the lifted edge to prevent it from falling forward. Remove the screws and bolts. Be sure that the transmitter does not slide down the skid when it is tilted.

d. Remove the following items from the drip pan under the keyer: 6 extra fuses for 115 volt operation, 2 heater elements for E3 for 115 volt operation, 1 bottle of oil for the keyer gear box, and 1 plastic funnel to be used when filling the keyer with oil. The keyer is mounted on right front of second shelf and is visible through middle panel of the right door (fig. 4). Remove the cloth bag attached to the keyer containing the extra identification switch segments. Remove the envelopes containing technical manuals and test data from the front of the transmitter.

e. Remove the side shields SH11, SH12, SH13, SH14, of the transmitter, and all blocking and tying. Do not use a screwdriver to tighten the panel fasteners. Open the front door and remove the cardboard wedge on quarter-phasing relay E11. Remove tying from all the large ferrule type resistors at the rear and inside of the transmitter. Remove tying from all tube cap leads.

9. SETTING UP THE TRANSMITTER AND REMOTE CONTROL UNIT

a. Detailed instructions for the location and external wiring to the transmitter are contained in the instructions accompanying the antenna system and housing which are to be used. Locate exactly as specified so that the r-f bus-bar forms up properly. Top view of the radio transmitter is shown in figure 12. Figure 13, system interconnection diagram, shows the antenna, power, and remote control line connections.

b. The remote control unit is normally installed in a control tower. It mounts in a 7 inch space in a standard 19 inch relay rack. The unit should be mounted in such a position that the microphone is conveniently located and the front panel is visible to the operator. Remove the protective wrapping from around rectifier tube V1R (fig. 68). Connect a 115 volt, 60 cycle, a-c power source through the twist-lock plug and receptacle at the rear. Connect one telephone line pair to terminals 1 and 2. Connect the other pair to terminals 4 and 5. Connect terminal 3 to a good ground.

c. At the transmitter, open both doors. Unscrew and remove the lower center panel SH3 (fig. 4). The power and control line terminal block is on the bottom shelf behind this panel. Connect either a 115 or 230 volt, 60 cycle, a-c power source to terminals 6 and 7. (The transmitter is set up for 230 volt operation at the factory. If 115 volt operation is desired, make all the necessary changes according to paragraph 12.) Connect terminal 3 to the station ground.

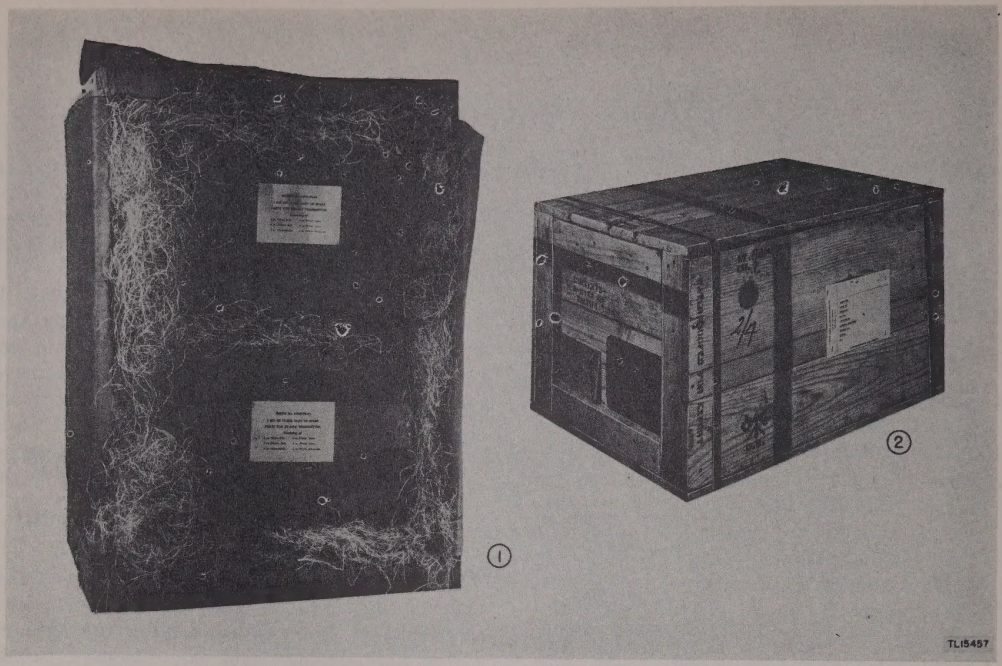


Figure 9. Packing case 2: (1) Open; (2) Closed.

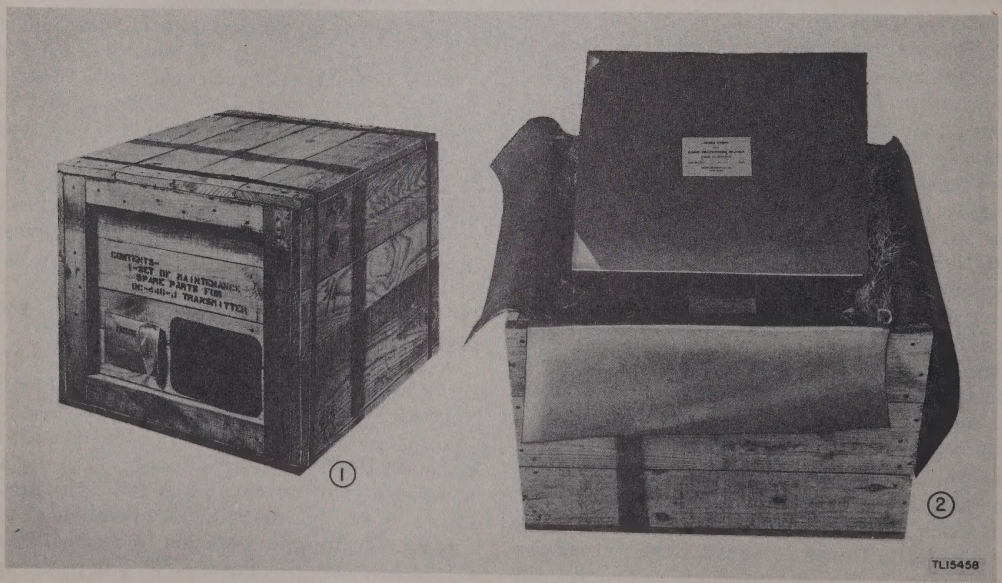


Figure 10. Packing case 3: (1) Closed; (2) Open.

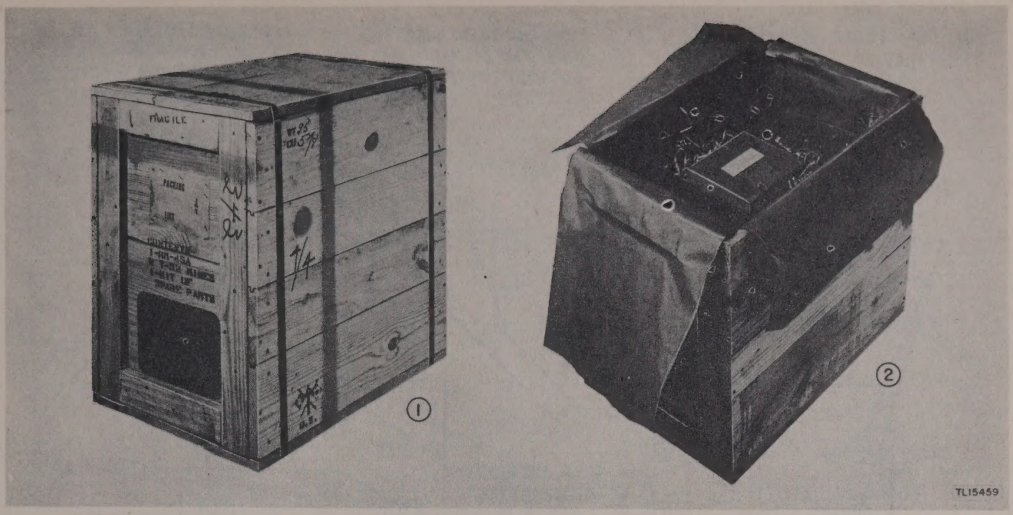


Figure 11. Packing case 4: ① Closed; ② Open.

d. It will now be necessary to identify the incoming telephone lines. Turn on the A.C. LINE switch and the RANGE switch at the remote control unit. The A.C. LINE amber pilot lamp should light. The fact that the RANGE pilot does not light does not indicate trouble. At the transmitter, determine by using a d-c voltmeter which one of the four telephone wires has voltage on it by placing the positive meter terminal on ground (terminal 3 of the transmitter), and then touching each of the telephone wires until a reading is obtained. As much as 35 volts may be indicated. Connect this telephone wire to the transmitter terminal 5. Relay E9 may operate if the ground resistance is not too high. Connect the two wires of the other telephone pair to terminals 1 and 2. This should operate relay E9 and cause the RANGE (green) pilot to light. Connect the remaining telephone wire to terminal 4. This completes the installation.

10. PREPARING THE REMOTE CONTROL UNIT FOR USE

a. Plug a microphone into the MICROPHONE JACK and depress the PRESS TO TALK tab. The VOICE (red) pilot will light. With the tab depressed, advance the MODULATION LEVEL control and talk into the microphone. It should be possible to get meter readings indicating 100

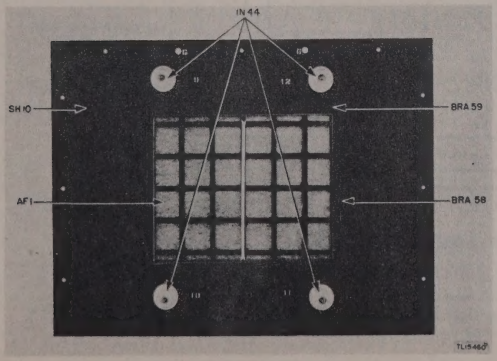
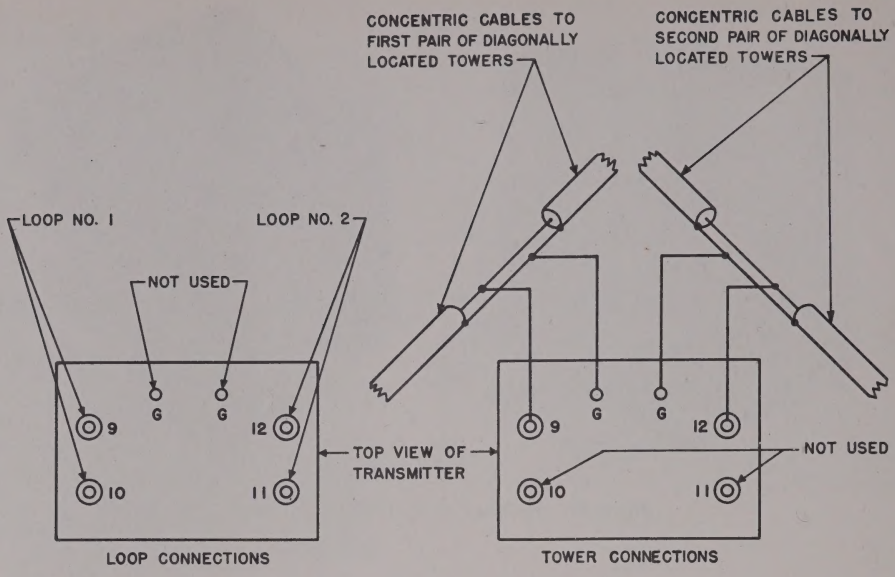
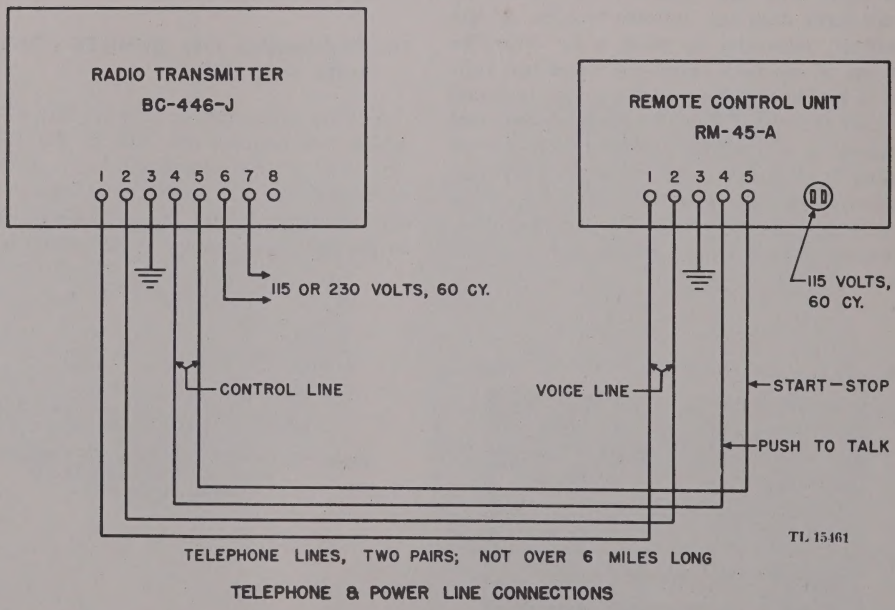


Figure 12. Radio Transmitter BC-446-J, top view, showing output feed-through studs and air filter.



ANTENNA CONNECTIONS FOR RADIO TRANSMITTER BC-446-J



TELEPHONE & POWER LINE CONNECTIONS

Figure 13. Radio Transmitter BC-446-J and Remote Control Unit RM-45-A, system interconnection diagram.

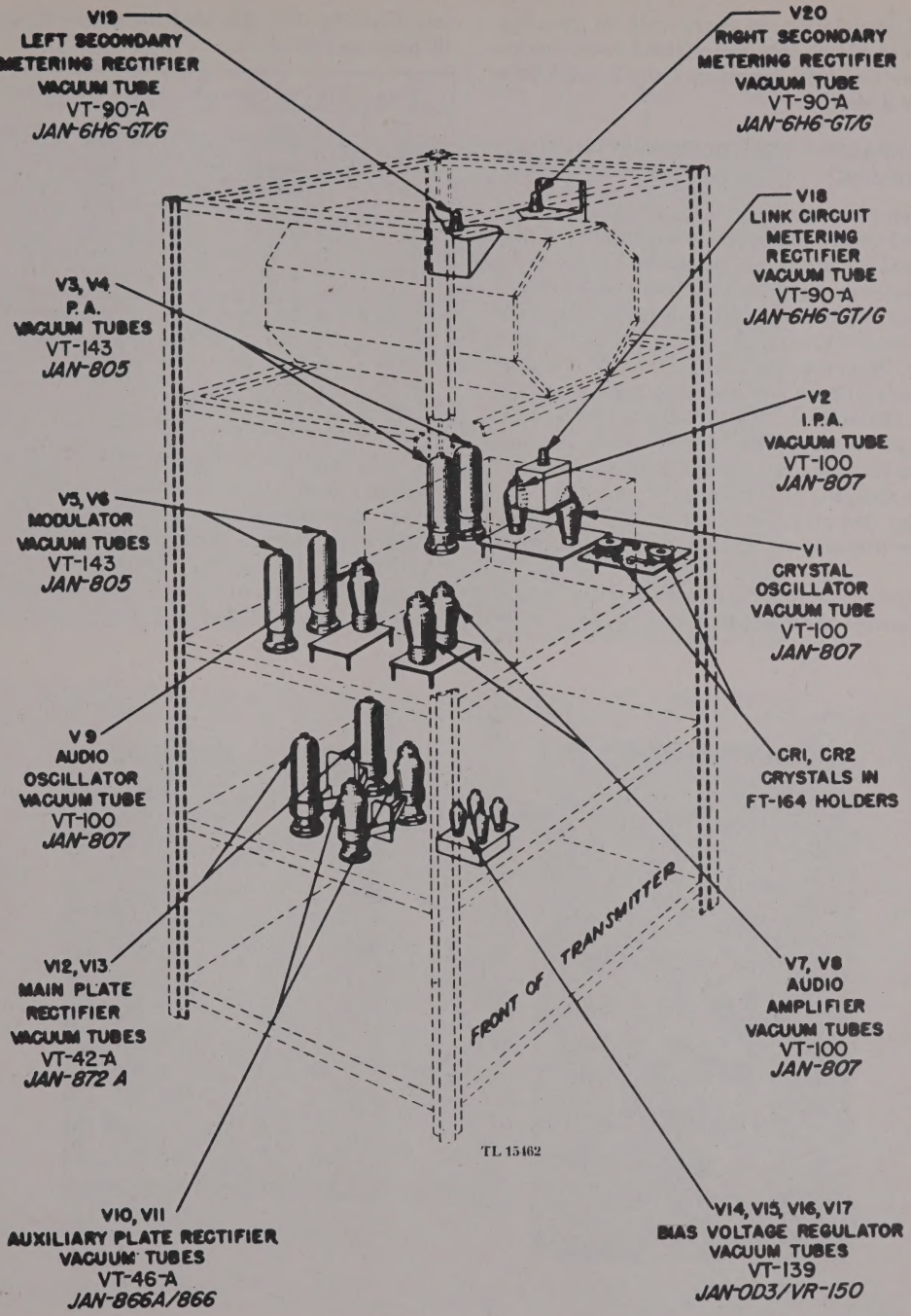


Figure 14. Tube location diagram for Radio Transmitter BC-446-J.

percent modulation on peaks without shouting. If this can not be obtained without removing the telephone line from terminals 1 and 2, check voice line for a short.

11. PREPARING THE TRANSMITTER FOR USE

a. Refer to the tube location diagram (fig. 14), and insert the proper tube in each socket. Note that all tubes can be inserted through the front doors except V19 and V20. Tubes V19 and V20 can be inserted after opening the front hatch cover CV2 (fig. 4) at the top of the goniometer. Place the crystals CR1 and CR2 in their receptacles. Check the supply voltage. It must be 105 to 125 volts or 210 to 250 volts at 57 to 63 cycles per second. The transmitter is normally shipped from the factory for 230 volt operation. Before applying power to the transmitter, it is essential that all primary voltage change connections be properly set and the proper fuses are in place.

b. The power fuses are located on the bakelite panel visible through the lowest window in the left door (fig. 15). See that the proper sizes are in place as follows:

Fuse	115 Volt Operation	230 Volt Operation
F1	3 amp	3 amp
F2	3 amp	3 amp
F3	1 amp	1 amp
F4	1 amp	1 amp
F5	3 amp	3 amp
F6	3 amp	3 amp
F7	10 amp	5 amp
F8	10 amp	5 amp
F9	1 amp Fusetron	1 amp Fusetron
F10	1 amp Fusetron	1 amp Fusetron
F11	10 amp	5 amp
F12	10 amp	5 amp
F14	5 amp	3 amp
F15	5 amp	3 amp

c. The MAIN POWER SWITCH, E3, is of the thermal overload type. It contains two removable heater elements. The proper elements are No. 81D-138 for 115 volt operation and No. 81D-133 for 230 volt operation. The elements are changed by removing the hatch panel CV1 (fig. 16) covering the front of the switch.

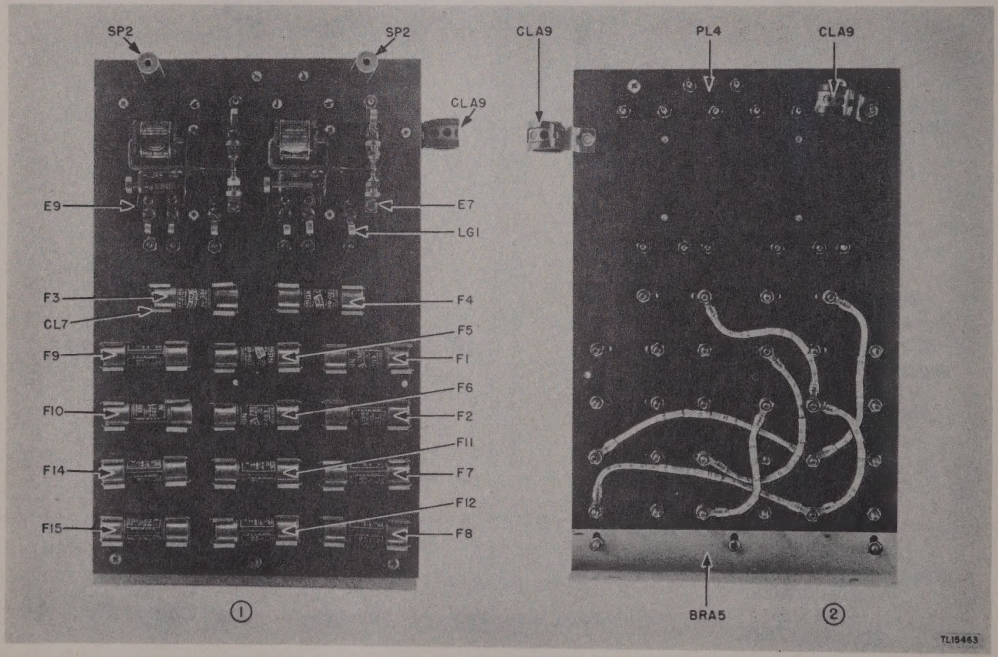


Figure 15. Fuse panel: ① Front view; ② Rear view.

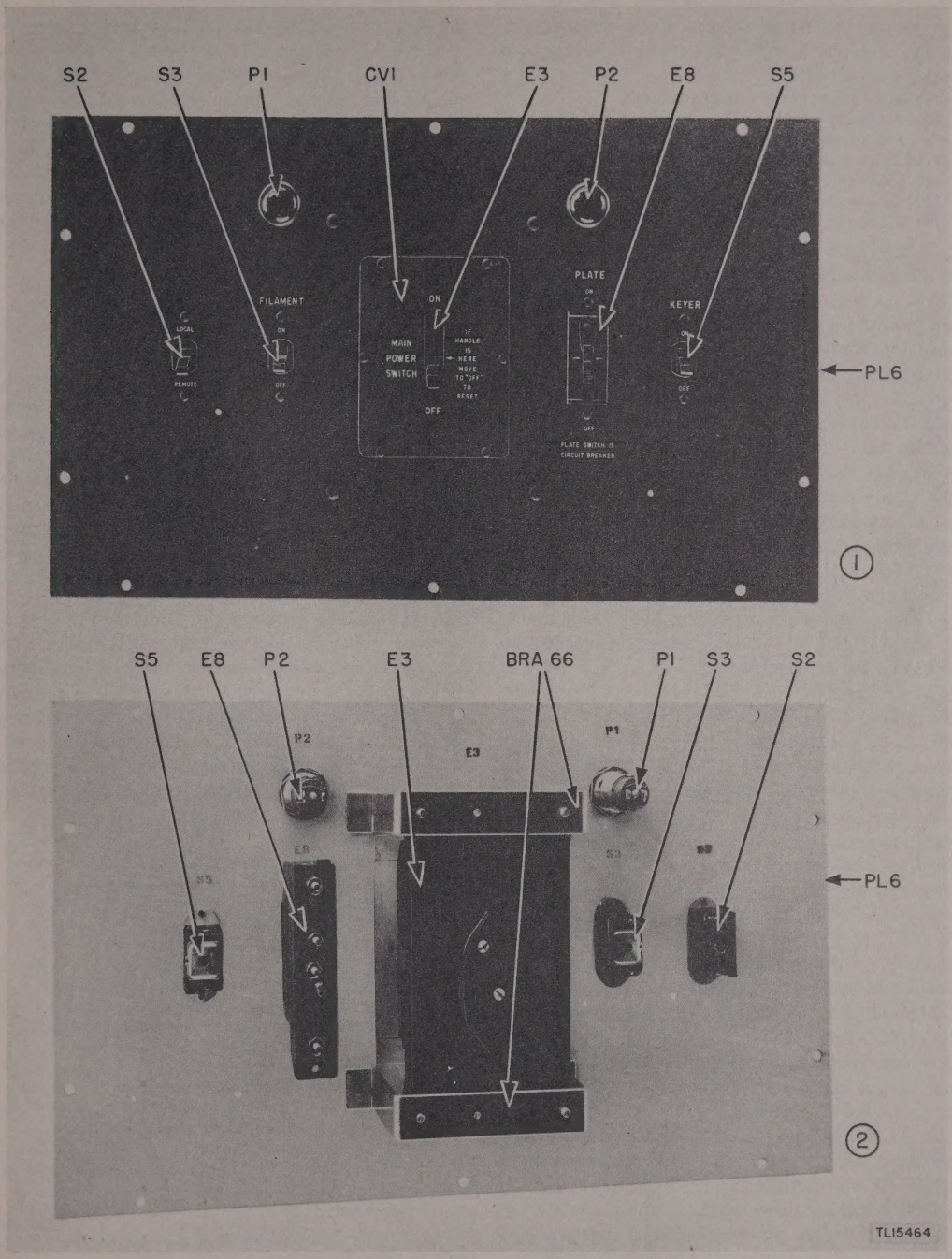


Figure 16. Switch panel: (1) Front view; (2) Rear view.

d. The following transformers and devices require the setting of taps or links for primary voltage (see fig. 17 for tap change points and proper connections):

(1) Main plate rectifier transformer T1
(2) Auxiliary plate rectifier transformer T4
(3) Relay rectifier transformer T6
(4) Relay auto-transformer T10
(5) Filament voltage regulator VR1
(6) Blower motor B1
(7) Mercury vapor tube heaters H1, H2, H3, H4

e. The radio range keyer E1 is shipped without oil, and is lubricated by the oil from the bottle which has been previously removed from the oil drip pan under the keyer. A funnel is used in this operation. Remove the 5 screws (3 top, 2 bottom) which mount the keyer panel to the support rails, and slide the keyer to the right until the hex-headed oil reservoir filling cap is accessible from the top. Remove the cap and fill the reservoir until the glass indicator shows NORM. Slide the keyer back in place and replace the screws.

f. The keyer normally leaves the factory with identification letters JY set up. If other letters have been assigned, set them up as instructed in paragraph 56.

g. When these preparations have been made, set the LOCAL REMOTE switch (fig. 16) to LOCAL, and turn ON the MAIN POWER SWITCH and FILAMENT switch. The green pilot and all tube filaments will light. It may be difficult to see the dull red glow of the mercury vapor rectifiers. Note that relay E5 produces a time delay which does not permit the plate voltage to be applied until the rectifier tubes are sufficiently heated. Operate the KEYER switch to ON. The keyer motor will start and the link circuit relay E2, behind the upper window of the left door (fig. 4), will operate. Set the A.C. METER SWITCH to FIL. and read the A.C. METER. If the supply voltage and frequency are within the proper limits, the meter will read within 2 volts of 115 volts. If it does not read that close, check the VOLTAGE REGULATOR CUT-OUT switch S4 on the bakelite panel behind the lowest window on the right door (fig. 18). It should be in the up or REG. position.

h. To check the operation of the remote control unit, set the LOCAL REMOTE switch to REMOTE and set the MAIN POWER SWITCH to ON. At the remote control unit, operate the A.C. LINE switch and the RANGE switch to ON (fig. 6). This will turn on the transmitter filaments.

i. After a 30-second time delay, depressing the microphone PRESS TO TALK tab will energize relays E7, E10, and E11 in the transmitter. E11 is the large mycalex panel solenoid type relay visible behind the upper window of the right door (fig. 4). When energized, the movable contact assembly moves up. If trouble occurs, it is most likely to be a reversal of the control line, so that the filaments are turned on by the microphone tab and the relays are energized by the range switch.

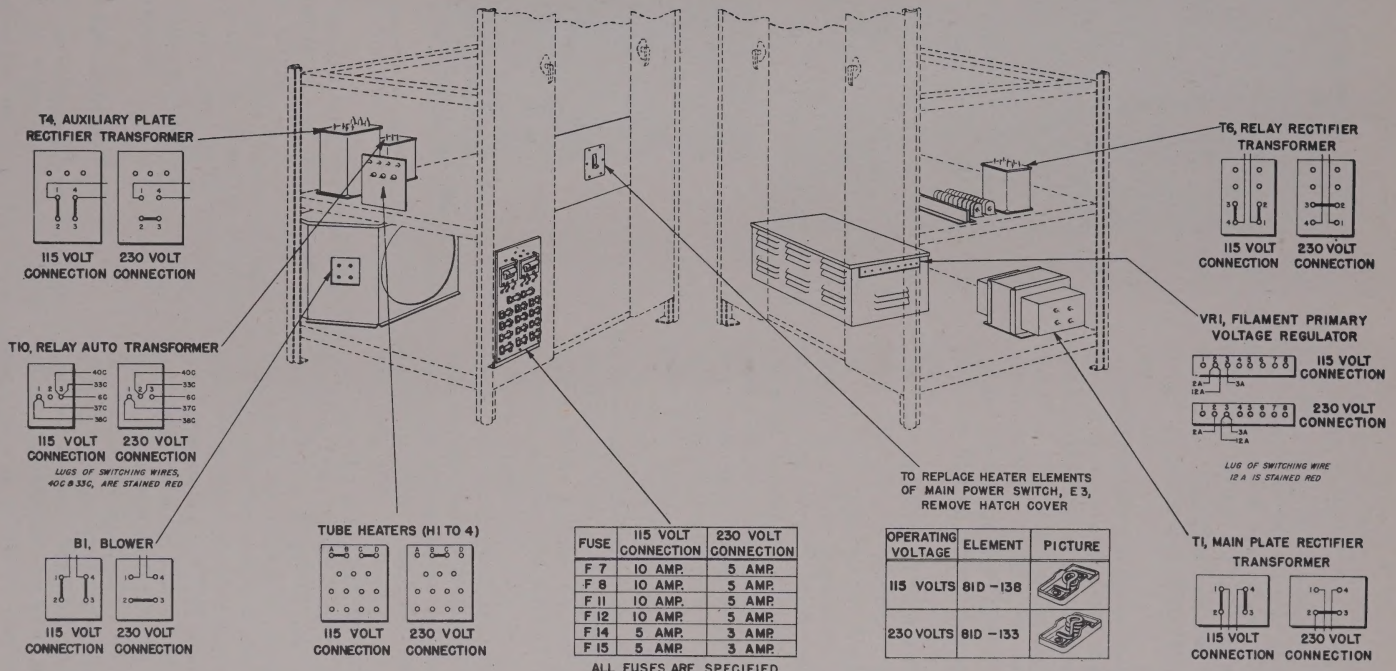
12. SETTING UP THE FREQUENCY CHANGE LINKS

a. Unless time does not permit, it is strongly recommended that the operator familiarize himself completely with section III of this manual before attempting to tune the transmitter. The circuits involved are inherently more complicated than in conventional communications transmitters, and in general must be tuned more carefully. An understanding of the circuits involved will be of great help to the operator.

b. There are a number of links and straps at various points inside the transmitter which select functions and frequency bands. These must be set before closing the side shields and doors as they are not accessible from the front. Figure 19 shows the location of the various adjusting links. The following list identifies the setting in each case for any desired frequency, antenna system, or course setting:

	Figure
P-a tank capacitor bank	20
Link tuning fixed capacitor bank	21
Quarter-phasing capacitor bank	21
Quarter-phasing inductor tap	21
Course shifting pad insertion links	27
Left goniometer primary capacitor bank	22
Left goniometer primary matching transformer tap	22
Right goniometer primary capacitor bank	22
Right goniometer primary matching transformer tap	22
Goniometer primary loading inductors	22
Left goniometer secondary capacitor bank	23, 24
Left goniometer secondary loop-tower selector links	19
Right goniometer secondary capacitor bank	23, 24
Right goniometer secondary loop-tower selector links	19

Note.—The transmitter normally leaves the factory set for tower antenna operation, with the course shifting pad out of circuit.


T4, AUXILIARY PLATE RECTIFIER TRANSFORMER
115 VOLT CONNECTION
230 VOLT CONNECTION
T10, RELAY AUTO TRANSFORMER
115 VOLT CONNECTION
230 VOLT CONNECTION
LUGS OF SWITCHING WIRES, 40C & 33C, ARE STAINED RED
B1, BLOWER
115 VOLT CONNECTION
230 VOLT CONNECTION
TUBE HEATERS (H1 TO 4)
115 VOLT CONNECTION
230 VOLT CONNECTION
TO REPLACE HEATER ELEMENTS OF MAIN POWER SWITCH, E3, REMOVE HATCH COVER
T6, RELAY RECTIFIER TRANSFORMER
115 VOLT CONNECTION
230 VOLT CONNECTION
VR1, FILAMENT PRIMARY VOLTAGE REGULATOR
115 VOLT CONNECTION
230 VOLT CONNECTION
LUG OF SWITCHING WIRE 12A IS STAINED RED
T1, MAIN PLATE RECTIFIER TRANSFORMER
115 VOLT CONNECTION
230 VOLT CONNECTION
TI. 15465

FUSE	115 VOLT CONNECTION	230 VOLT CONNECTION
F 7	10 AMP.	5 AMP.
F 8	10 AMP.	5 AMP.
F 11	10 AMP.	5 AMP.
F 12	10 AMP.	5 AMP.
F 14	5 AMP.	3 AMP.
F 15	5 AMP.	3 AMP.

ALL FUSES ARE SPECIFIED IN PARAGRAPH 11B

OPERATING VOLTAGE	ELEMENT	PICTURE
115 VOLTS	81D-138	
230 VOLTS	81D-133	

Figure 17. 115-230 volt connections.

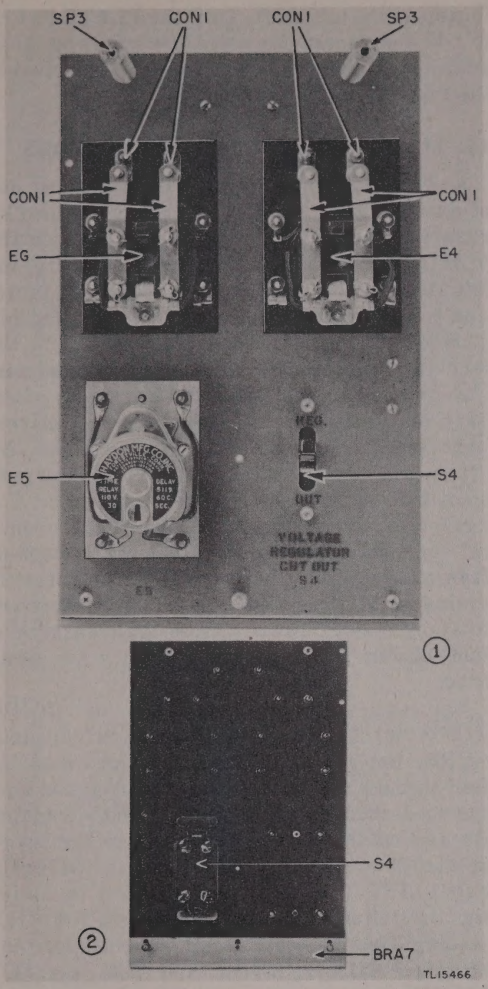


Figure 18. Primary power relay panel: (1) Front view; (2) Rear view.

c. Set up all the links, straps, and connectors listed above as directed in the diagrams. Since there are so many settings it is desirable to check them off against the list. The course shifting L pad should be left out of the circuit until the transmitter is completely tuned. Directions for connecting the course shifting L pad resistors are given in paragraph 17.

13. TUNING VACUUM TUBE CIRCUITS

a. These circuits are completely conventional and tune in the same manner as most multistage crystal controlled transmitters. Set VOICE GAIN (fig. 25) and TONE GAIN controls to 0. Set OUTPUT COUPLING dial to 0. Set the CRYSTAL TUNING, I.P.A. TUNING, and P.A. TUNING dials to calibrations shown on figure 20. Make sure that all side shields are in place and both doors are closed. With the LOCAL REMOTE switch in LOCAL position and the PLATE and KEYER switches OFF, operate the MAIN POWER and FILAMENT switches to ON

CAUTION.—When the transmitter is tuned for the first time, tuning of each stage should be carried out as rapidly as possible and the plate switch should be turned off immediately after the stage is tuned. This is necessary to avoid possible damage to succeeding stages caused by excessive plate currents flowing when they are not properly tuned.

b. Set the D.C. METER SWITCH to CRYSTAL OSC. If the equipment is being operated for the first time, let the filaments operate for 10 minutes before proceeding. This is necessary to allow the mercury in the rectifiers to become properly distributed. This preliminary warm-up is necessary every time a mercury vapor rectifier tube is removed and replaced. After the delay operate the PLATE switch to ON. The red pilot will light.

c. Tune the CRYSTAL TUNING dial for a minimum reading on the D.C. METER (D.C. METER SWITCH is still set to CRYSTAL OSC.) After finding the setting for minimum current, increase the CRYSTAL TUNING dial reading slightly, so that the current reading is about 3 milliamperes above the minimum. Note that on this switch position, the D.C. METER reads 50 milliamperes full scale. Operate the PLATE switch to OFF and lock the CRYSTAL TUNING dial.

d. Set the D.C. METER SWITCH to I.P.A. position. Operate the PLATE switch to ON and tune the I.P.A. TUNING dial for minimum reading on the D.C. METER. Operate the PLATE switch to OFF and lock the I.P.A. TUNING dial. If the meter shows no intermediate p-a current, operate the KEYER switch to ON and let the keyer run until intermediate p-a current appears. Then operate it to OFF. It is possible that the keyer has stopped in KEY-OPEN position during the identification keying cycle.

e. Set the D.C. METER SWITCH to P.A. position. Operate the PLATE switch to ON and tune the P.A. TUNING dial for minimum read-

ing on the D.C. METER. Lock the P.A. TUNING dial. The vacuum tube circuits are now tuned, and should need no subsequent adjustment.

14. TUNING THE LINK CIRCUIT

a. Set LINK SWITCH to LINK TUNE and the D.C. METER SWITCH to LINK CURR. Advance the OUTPUT COUPLING dial reading and tune the LINK TUNING dial for maximum reading on the D.C. METER. Reduce the OUTPUT COUPLING, if necessary, to avoid driving the meter off-scale at the maximum. If the maximum occurs at 100 on the LINK TUNING dial, reset the link tuning fixed capacitor bank to the next higher frequency band given in figure 21. If the maximum occurs at 0, use the next lower frequency band. When a true maximum is found, lock the LINK TUNING dial and operate the PLATE switch to OFF.

15. TUNING GONIOMETER PRIMARIES

a. Open the goniometer secondary circuits by disconnecting the bus-bar leads from both rear feed-through insulators on top of the transmitter. Leave the D.C. METER switch on LINK CURR. and set the LINK SWITCH to GONIO TUNE. Make sure the KEYER switch is set at OFF and note whether the link circuit relay E2 (fig. 4) is pulled to the right or left. If there is any doubt as to the position of the link circuit relay, operate the KEYER switch to ON for a while, and observe the action of the relay. Operate the KEYER to OFF and note whether the link circuit relay stops on the left or the right side.

b. If the relay is on the right, the right goniometer PRIMARY TUNING dial can be tuned and vice versa. Leave the OUTPUT COUPLING dial on the same setting used in tuning the link circuit. Operate the PLATE switch to ON and tune the proper PRIMARY TUNING dial for a maximum reading on the D.C. METER. If the maximum occurs at 100 on the dial, reset both goniometer primary capacitor banks to the next higher frequency range shown in figure 22. If the maximum is found at 0, use the next lower frequency.

c. After the first primary is properly tuned, operate the plate switch to OFF and lock the dial. Operate the KEYER to ON and then to OFF so that the link circuit relay stops on the other side (i.e., if the relay has been on the right side and hence the right hand PRIMARY TUNING dial has just been set, get the relay to stop on the left side). Turn the PLATE switch to ON and repeat the procedure with the other goniometer primary. Lock the dial and operate the PLATE switch to OFF.

16. TUNING GONIOMETER SECONDARIES

a. The goniometer secondaries are tuned one at a time. First, the right secondary is tuned by replacing the output lead removed to tune the primaries. This lead is then removed again, the left lead replaced, and the left secondary tuned. The secondaries are tuned by the "reflected impedance" method. This method is based on the fact that the secondary will reflect the maximum impedance into the primary, when the secondary is resonated. This condition is sharply indicated by minimum link circuit current. *No attempt is made to tune by secondary current,* since that method may lead to serious error. The method of resonating the secondaries is identical whether the transmitter is feeding loops or transmission lines. The only difference is that in tuning into transmission lines, it is necessary to apply a short circuit across the transmission lines exactly at the point where they are paralleled.

b. Leave the LINK SWITCH on GONIO TUNE and the D.C. METER SWITCH on LINK CURR. Replace the lead to the right rear top feed-through insulator, and, if transmission lines are used, short circuit both right and left output circuits *exactly* at the points where the transmission lines tie in parallel. Leave the OUTPUT COUPLING dial at the setting used in tuning the link circuit and the primaries. Note this reading. Operate the PLATE switch to ON. Rotate the GONIOMETER and note the D.C. METER reads a maximum near either 90° or 0°, and a minimum 90° from the maximum. Set the GONIOMETER so that the meter reads about one-half the maximum and tune the right goniometer SECONDARY TUNING dial for a *minimum* meter reading.

c. If the meter reading drops too low for observation, increase OUTPUT COUPLING. It should be possible to locate the SECONDARY TUNING dial setting for minimum current within a few points on the dial. If the loops are being tuned, some increase in sharpness can be obtained by setting the LINK SWITCH to READ for the final fine adjustment. Do not do this until the final adjustment since it removes a protective resistor from the link circuit.

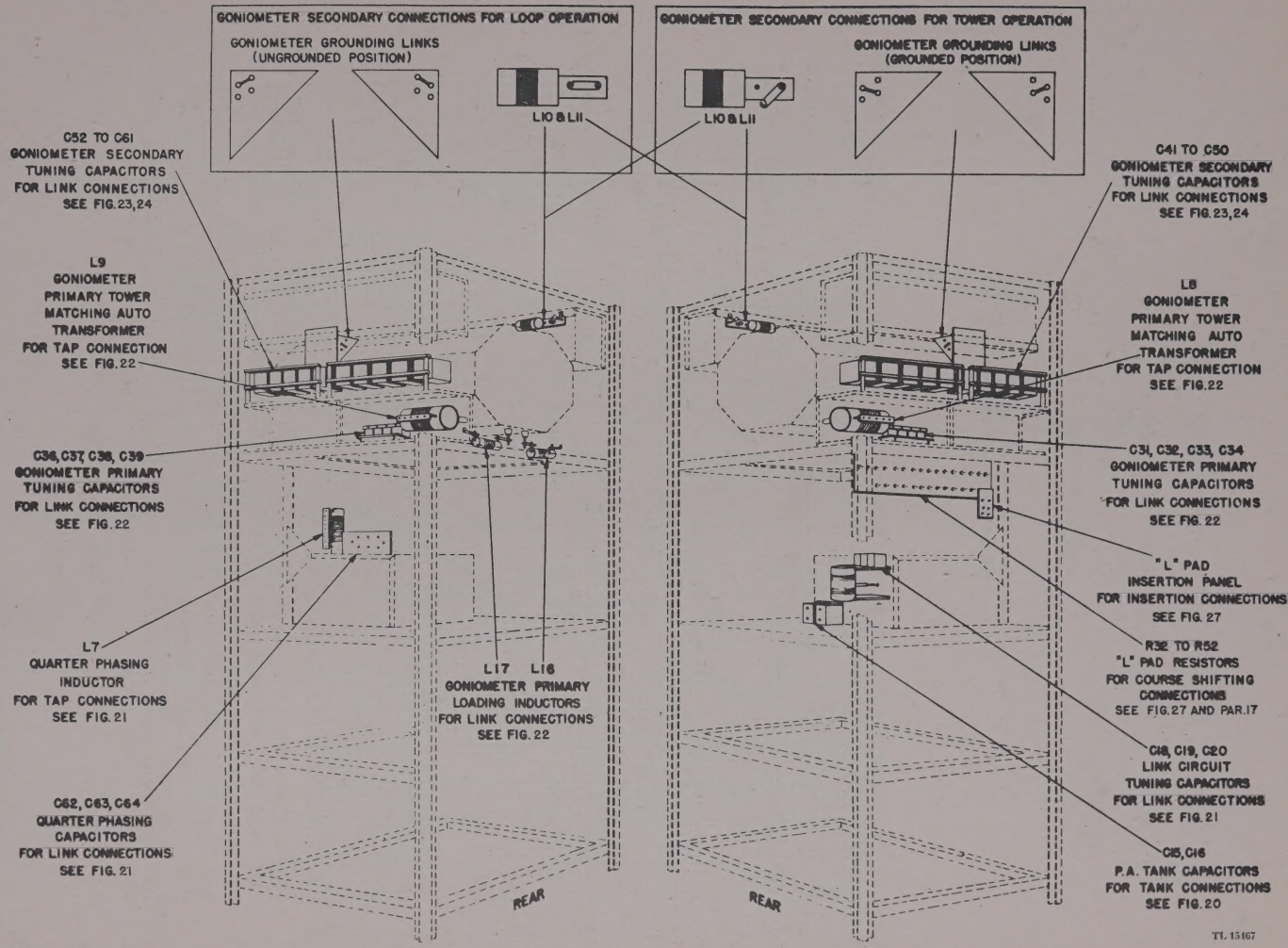
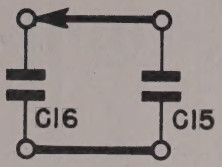

GONIOMETER SECONDARY CONNECTIONS FOR LOOP OPERATION
GONIOMETER GROUNDING LINKS (UNGROUNDED POSITION)
L10 & L11
GONIOMETER SECONDARY CONNECTIONS FOR TOWER OPERATION
GONIOMETER GROUNDING LINKS (GROUNDED POSITION)
L10 & L11
C52 TO C61 GONIOMETER SECONDARY TUNING CAPACITORS FOR LINK CONNECTIONS SEE FIG. 23, 24
C41 TO C50 GONIOMETER SECONDARY TUNING CAPACITORS FOR LINK CONNECTIONS SEE FIG. 23, 24
L9 GONIOMETER PRIMARY TOWER MATCHING AUTO TRANSFORMER FOR TAP CONNECTION SEE FIG. 22
L8 GONIOMETER PRIMARY TOWER MATCHING AUTO TRANSFORMER FOR TAP CONNECTION SEE FIG. 22
C36, C37, C38, C39 GONIOMETER PRIMARY TUNING CAPACITORS FOR LINK CONNECTIONS SEE FIG. 22
C31, C32, C33, C34 GONIOMETER PRIMARY TUNING CAPACITORS FOR LINK CONNECTIONS SEE FIG. 22
"L" PAD INSERTION PANEL FOR INSERTION CONNECTIONS SEE FIG. 27
R32 TO R52 "L" PAD RESISTORS FOR COURSE SHIFTING CONNECTIONS SEE FIG. 27 AND PAR. 17
L7 QUARTER PHASING INDUCTOR FOR TAP CONNECTIONS SEE FIG. 21
L17 L16 GONIOMETER PRIMARY LOADING INDUCTORS FOR LINK CONNECTIONS SEE FIG. 22
C18, C19, C20 LINK CIRCUIT TUNING CAPACITORS FOR LINK CONNECTIONS SEE FIG. 21
C62, C63, C64 QUARTER PHASING CAPACITORS FOR LINK CONNECTIONS SEE FIG. 21
C15, C16 P.A. TANK CAPACITORS FOR TANK CONNECTIONS SEE FIG. 20
REAR
REAR
TL 15467

Figure 19. Location of frequency change links.



C15 and C16 link connections (low frequency band). Open link for high frequency band.

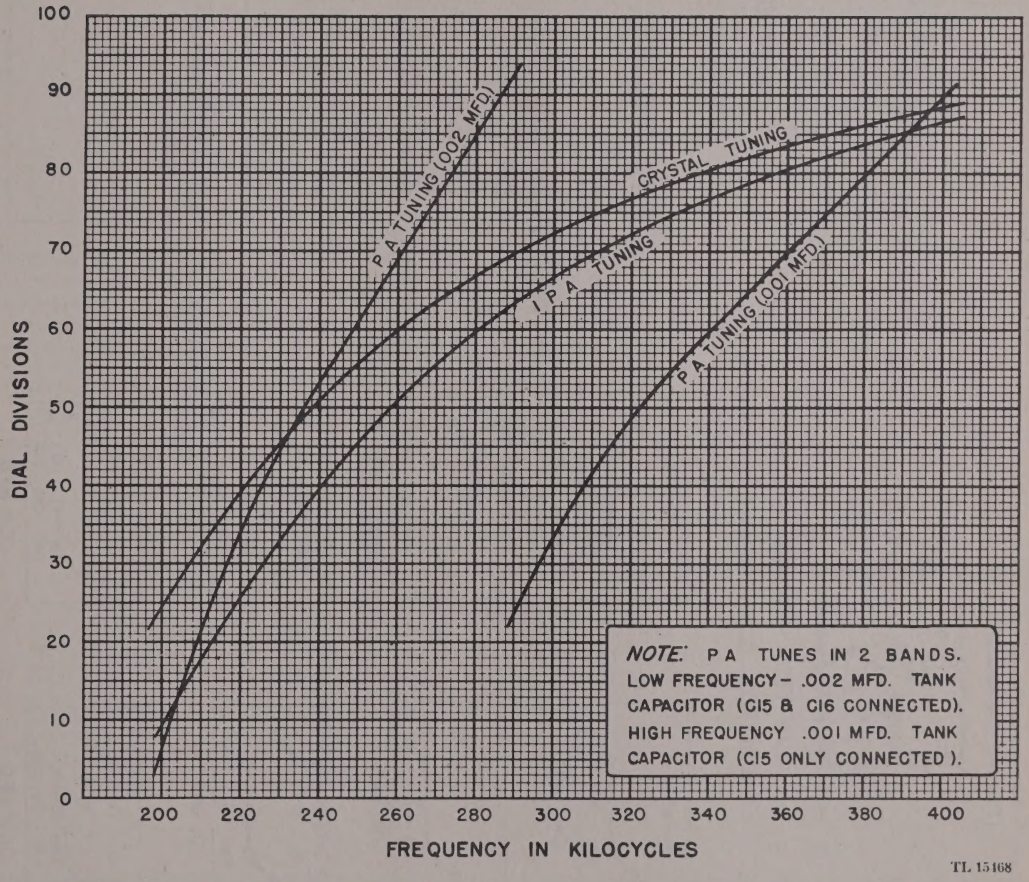
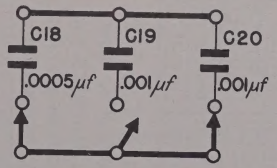
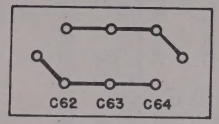


Figure 20. Crystal oscillator, intermediate power amplifier, and power amplifier dial calibration chart.

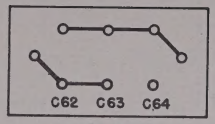
Link connections for C18, C19, and C20 (C18 and C20 connected, C19 disconnected).



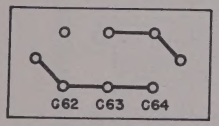
QUARTER PHASING CAPACITOR CONNECTIONS



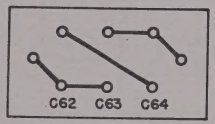
.014 MFD.



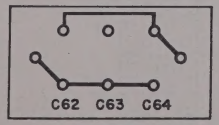
.006 MFD.



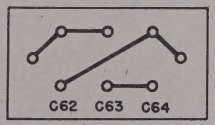
.012 MFD.



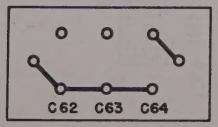
.0056 MFD.



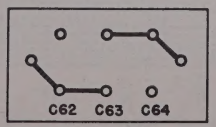
.01 MFD.



.0047 MFD.



.008 MFD.



.004 MFD.

Figure 21. Link circuit and quarter-phasing tuning bands.

LINK CIRCUIT TUNING CAPACITOR CONNECTIONS

FOR CAPACITOR LOCATION SEE FIG. 19

FREQ.-K.C.	CAPACITANCE	CAPACITORS USED
195 – 205	.0025	C18, C19, C20
205 – 225	.002	C19, C20
225 – 260	.0015	C18, C19
260 – 300	.001	C19
300 – 405	.0005	C18

QUARTER PHASING CONNECTIONS

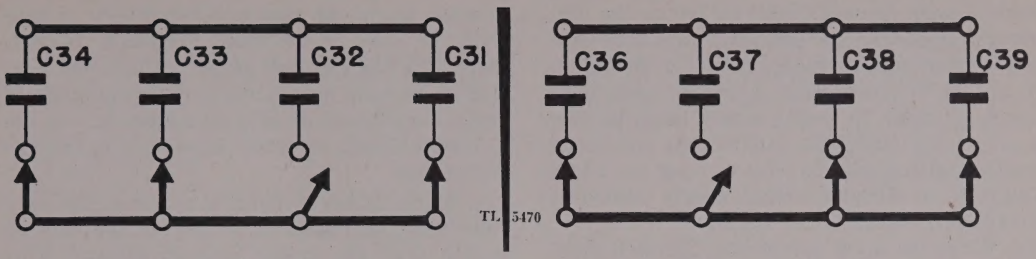
FOR INDUCTOR & CAPACITOR LOCATION SEE FIG. 19
FOR CAPACITOR CONNECTIONS SEE ADJACENT DRAWINGS

TOWER ANTENNA

QUARTER PHASING INDUCTOR – L7		QUARTER PHASING CAPACITORS	
FREQ.-K.C.	TAP	FREQ.-K.C.	CAPACITANCE
200 – 207	3	200 – 227	.006
208 – 213	2	228 – 232	.0047
214 – 232	1	233 – 257	.008
233 – 243	4	258 – 282	.006
244 – 262	3	283 – 292	.0056
263 – 292	2	293 – 312	.008
293 – 307	5	313 – 342	.006
308 – 317	4	343 – 352	.0056
318 – 322	5	353 – 362	.004
323 – 337	4	363 – 377	.006
338 – 342	3	378 – 387	.0056
343 – 362	4	388 – 400	.0047
363 – 368	6		
369 – 387	5		
388 – 393	6		
394 – 400	5		

LOOP ANTENNA

QUARTER PHASING INDUCTOR – L7	QUARTER PHASING CAPACITORS	
	FREQ.-K.C.	CAPACITANCE
USE TAP 5 200 – 400 K.C.	200 – 209	.014
	210 – 229	.012
	230 – 249	.010
	250 – 289	.008
	290 – 329	.006
	330 – 349	.0056
	350 – 400	.004



Sample link connections for capacitors C31-C34.

Sample connections for capacitors C36-C39.

LOOP ANTENNA CONNECTIONS

Use tap 1 on Goniometer primary matching transformer L8 and L9

Freq. (kc)	Loading inductors L16 and L17	Capacity	Capacitors	
			Left bank	Right bank
195-203	In	0.0055	C31, C32, C33, C34	C36, C37, C38, C39
204-212	In	0.005	C32, C33, C34	C37, C38, C39
213-222	In	0.0045	C31, C33, C34	C36, C38, C39
223-237	In	0.004	C33, C34	C38, C39
238-250	Shorted	0.004	C33, C34	C38, C39
251-264	Shorted	0.0035	C31, C32, C33	C36, C37, C38
265-284	Shorted	0.003	C32, C33	C37, C38
285-309	Shorted	0.0025	C31, C33	C36, C38
310-339	Shorted	0.002	C33	C38
340-380	Shorted	0.0015	C31, C32	C36, C37
381-405	Shorted	0.001	C32	C37

TOWER ANTENNA CONNECTIONS

Primary Loading Inductors L16 and L17 shorted out

Freq. (kc)	Matching Transformer Tap L8 and L9	Capacity	Capacitors	
			Left bank	Right bank
195-204	5	0.0045	C31, C33, C34	C36, C38, C39
205-214	5	0.004	C33, C34	C38, C39
215-229	5	0.0035	C31, C32, C33	C36, C37, C38
230-242	4	0.003	C32, C33	C37, C38
243-262	4	0.0025	C31, C33	C36, C38
263-284	4	0.002	C33	C38
285-294	4	0.0015	C31, C32	C36, C37
295-332	3	0.0015	C31, C32	C36, C37
335-362	3	0.001	C32	C37
363-405	2	0.001	C32	C37

Figure 22. Goniometer primary tuning band connections.

d. If the SECONDARY TUNING dial setting for minimum current occurs at 100 on the dial, change the goniometer secondary capacitor bank to the next higher frequency shown in figures 23 and 24. If it occurs at 0, try the next lower frequency band. In trying a new band, be sure to return the OUTPUT COUPLING dial to the original setting, and be sure to reset the LINK SWITCH to GONIO TUNE before operating the PLATE switch to ON again.

e. When the right goniometer SECONDARY TUNING dial has been set satisfactorily, operate the PLATE switch to OFF and lock the dial. Remove the top right rear feed-through lead again and replace the left top rear lead. Reset the OUTPUT COUPLING dial to the reading noted above and reset the LINK SWITCH to GONIO TUNE. Tune the left goniometer SECONDARY TUNING dial, using the same procedure used for the right secondary. Note that the GONIOMETER will have to be reset.

f. When both secondaries have been tuned, operate the PLATE switch to OFF, connect all top output leads permanently, and remove the transmission line shorts. Set the LINK SWITCH on READ.

17. SETTING COURSES

a. If loops are used, the station tuning procedure is now complete, and courses may be set. If towers and transmission lines are used, it is now necessary to tune the towers as directed in the antenna tuning unit instructions. When the towers have been tuned, and transmission lines properly connected, proceed as follows: Set the GONIOMETER on 45°, then turn the KEYER switch to ON, and operate the PLATE to ON. Advance the OUTPUT COUPLING until the P.A. reads 210 milliamperes on the D.C. METER. Set the TONE FREQUENCY switch to either 500 or 1,020 cycles per second as required. Set the A.C. METER SWITCH on MOD. and advance the TONE GAIN dial until the A.C. METER reads 90 volts. Note the D.C. METER readings on P.A., LINK CURR., and LEFT and RIGHT SEC. CURR. These readings may change slightly as the link circuit relay operates. (During the period of identification keying every $\frac{5}{8}$ minute, all these readings will follow the keying.) The LEFT and RIGHT SEC. CURR. readings should be substantially equal.

b. Leave the equipment in operation and listen to the signal at various points at least 1,000 feet beyond the nearest tower or pole, using a portable receiver with a rod antenna. Four courses should be found, substantially in line with the loops or the tower diagonals. (GONIOMETER has been left on 45°.) Check the location of A and N quadrants. If these are reversed from the desired general arrangement, set the GONIOMETER on 135°. Lock the GONIOMETER dial.

c. If no course shifting is required, the only remaining operation is to center the desired course over the proper airport runway. This can be done by ground check on the runway, followed by flight check. If the towers (or loops) have been properly located, the final goniometer setting will be close to 45° or 135°.

d. If course shifting is required, operate the PLATE to OFF and set the course shifting pad insertion links as shown in figure 27. Refer to figure 19 for location of L pad. Figure 26 shows front and rear views. If the N quadrants are to be squeezed (i.e., the N quadrants will occupy angles less than 90°) insert the pad in the left or N primary and vice versa.

e. From the curve of current ratio versus subtended angle (fig. 28), determine the desired current ratio. If loop antennas are used, refer to curve R_0 versus frequency for the predicted reflected goniometer primary resistance R_0. If tower antennas are used, assume the reflected goniometer primary resistance R_0 to be 80 ohms. Refer to figure 29 for the proper values of series and shunt arm resistance for the course shifting pad. Note that the curves show R Shunt/R_0 and R Series/R_0, and hence the values read must be multiplied by R_0 to obtain the proper number of ohms. Example: If the N quadrants are to be 75° wide, frequency 325 kc. From curve (A), figure 28, desired current ratio is 0.77. Frequency is 325 kc. If loops are used, curve (B), figure 28, shows R_0 is 95 ohms. (If towers are used, assume R_0 is 80 ohms at any frequency.) From figure 29 find R Series/R_0 is 0.225 (left scale) and R Shunt/R_0 is 3.45 (right scale) for current ratio of 0.77. Multiply these values by R_0 (95 ohms in this case) and obtain R series of 21 ohms and R shunt of 328 ohms.

f. Refer to figure 27 for the method of setting up the course shifting pad links. Note that the shunt arm can only be set in steps of 5 ohms and the series arms in steps of 1 ohm. These steps are fine enough to get the desired results. In the case of the example above, the shunt arm would be set to 330 ohms.

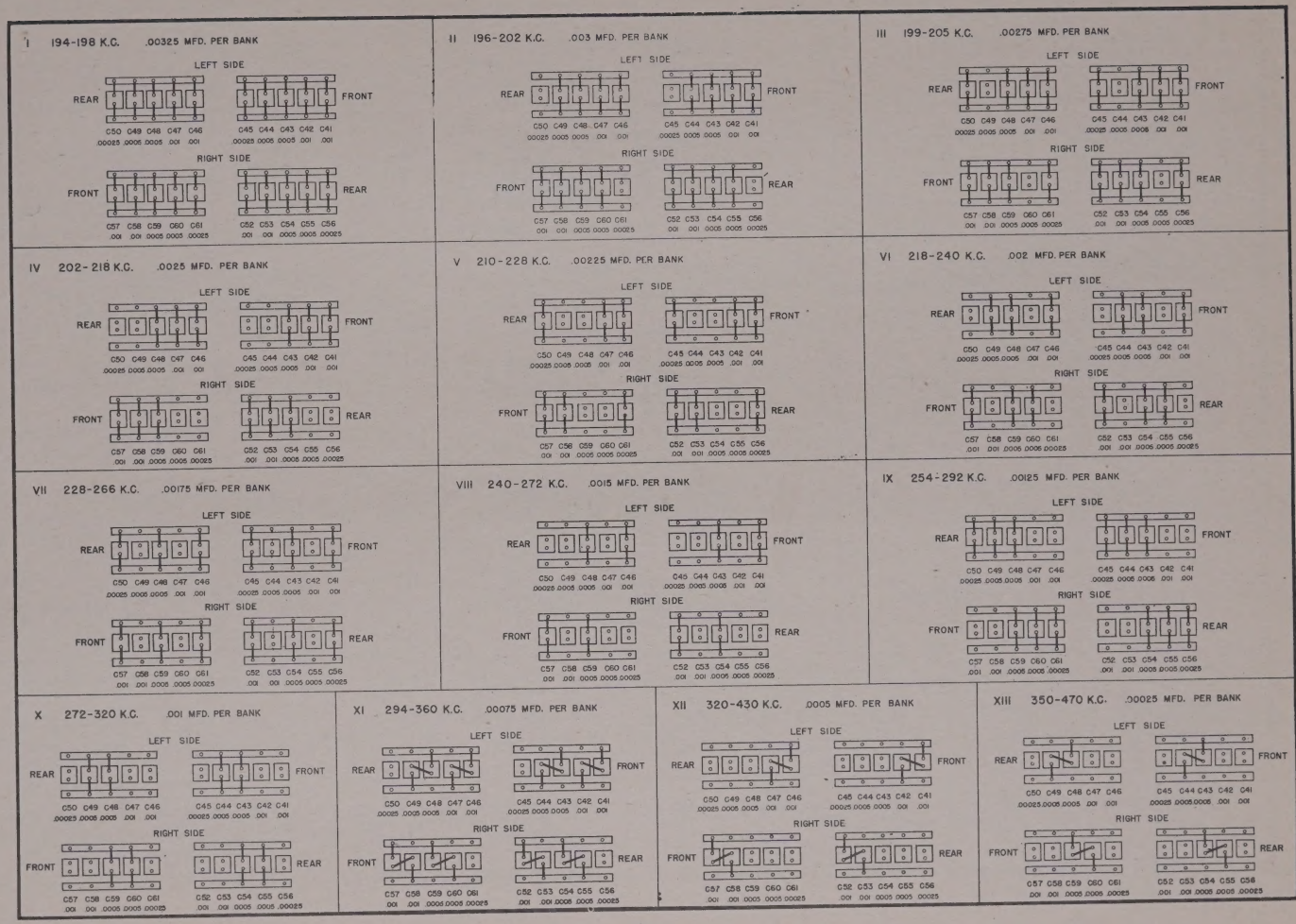


Figure 23. Goniometer secondary tuning bands, loop connection.

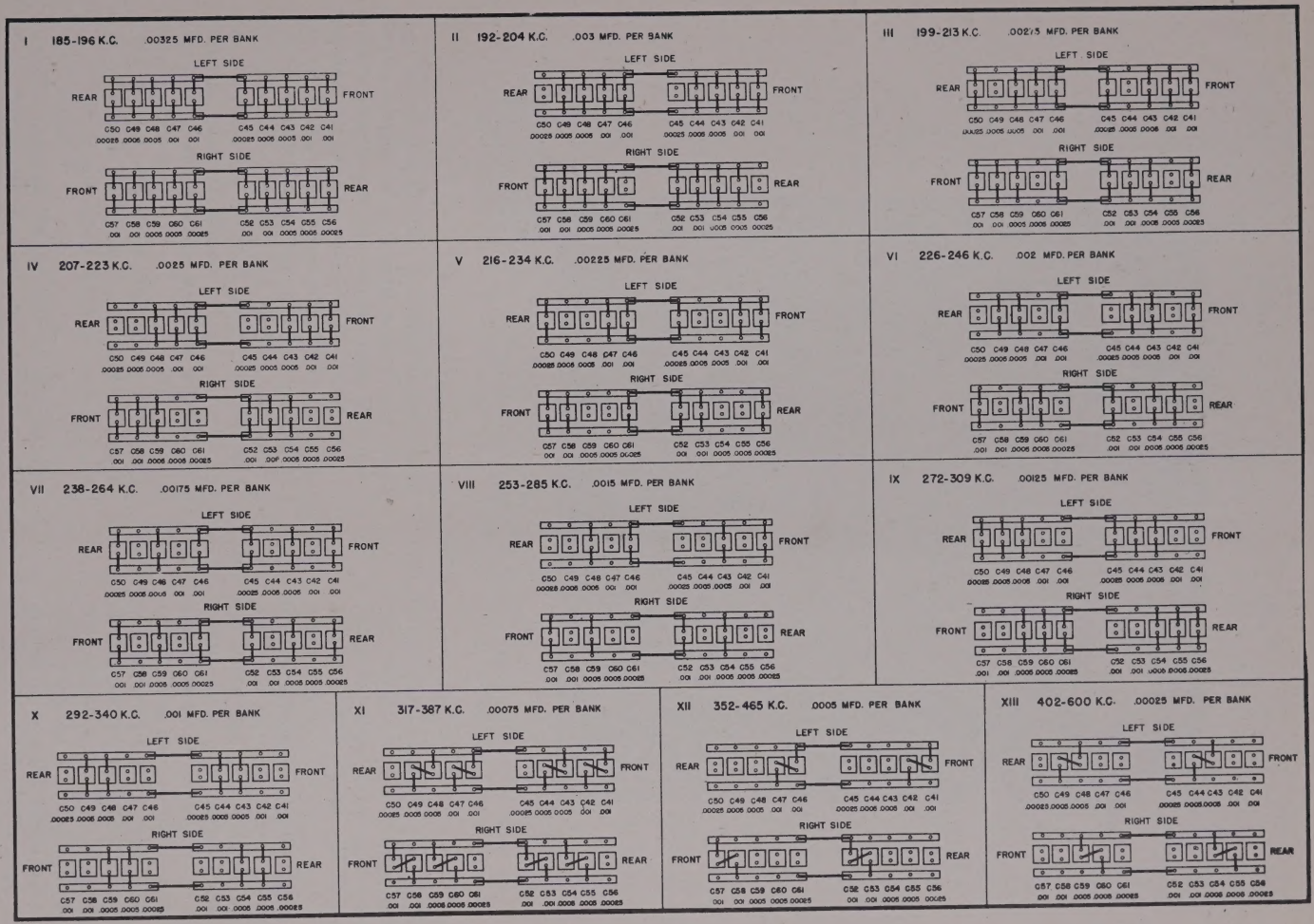


Figure 24. Goniometer secondary tuning bands, tower connection.

TL 15472

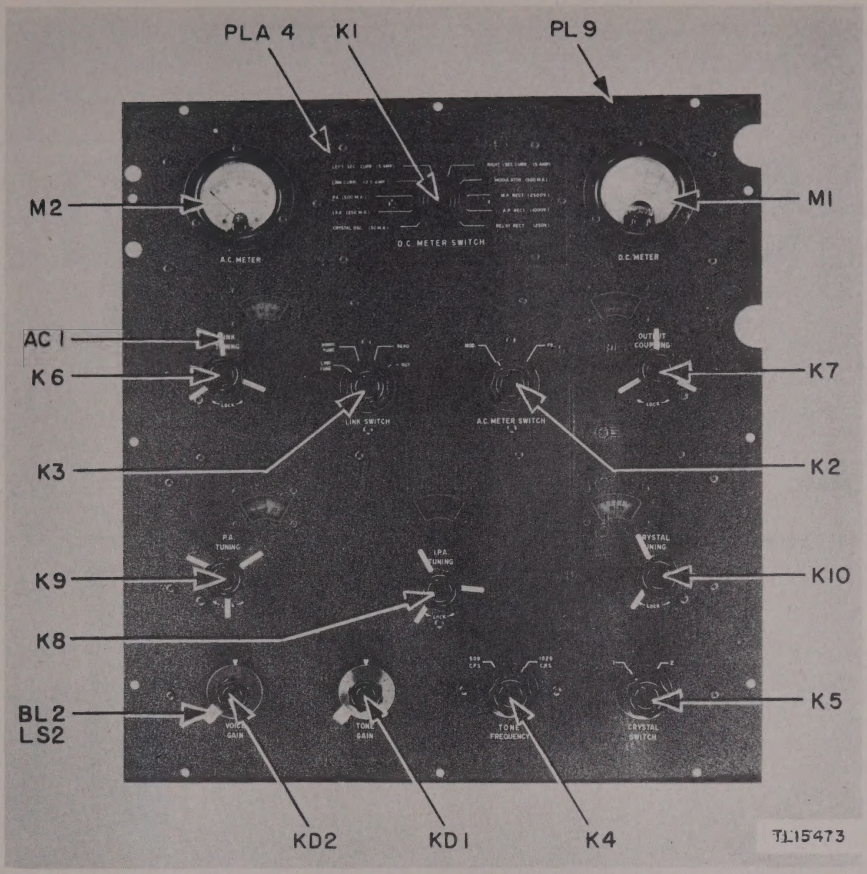


Figure 25. Meter and control unit, front panel view.

g. The course shifting pad adjustment found by this method is only preliminary and theoretical and will rarely be exactly right. The final and proper adjustment will be one in which the courses are at the required position and the p-a plate current does not swing more than 10 milliamperes when the link circuit relay operates. Operate the PLATE switch to ON and check the course positions.

h. The following rules apply in making the final adjustments:

(1) Do not rely on ground checks in mountainous areas, near bodies of water, or near power lines, telephone lines, or wire fences.

(2) To increase the amount of squeeze, decrease the R shunt and increase the R series and vice versa.

(3) If p-a plate current increases when the link circuit relay is thrown to the side containing the course shifting pad, increase both R series and R shunt and vice versa.

(4) Take all changes in small steps, so as to approach the best setting gradually.

(5) For a final fine adjustment of squeeze, R series or R shunt can be changed in small steps individually. It is not necessary to hold the p-a plate current swing to less than 10 milliamperes. The courses should not be considered final and used for navigation until all courses have been flight checked and actual bearings reported by qualified personnel.

i. Keep the GONIOMETER dial locked to avoid unauthorized changes in its setting.

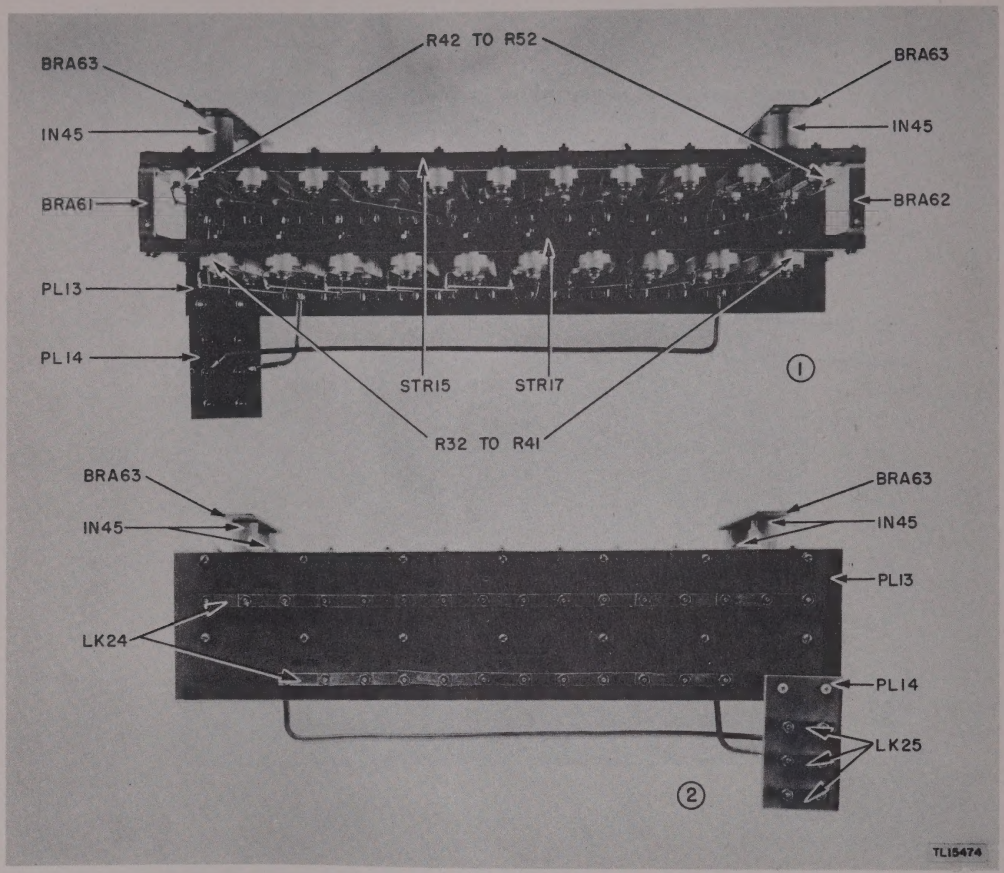


Figure 26. Course shifting L pad: ① Front view; ② Rear view.

18. VOICE OPERATION

a. The only adjustment necessary for voice operation is the setting of the gain controls. The MODULATION LEVEL control on Remote Control Unit RM-45-A should be set so that when the operator talks in a normal voice the meter reads 100 percent modulation on peaks. With the operator at the remote unit holding a sustained tone so that his meter reads 50 percent modulation, the VOICE GAIN control on the transmitter should be set so that the A.C. METER reads 57 volts with the A.C. METER SWITCH on MOD.

b. If an audio oscillator is available this operation can be considerably facilitated. At the remote unit, connect the oscillator output across terminals 1 and 2, leaving the telephone lines connected. Depress microphone tab and increase audio oscillator output until the meter on the remote control unit reads 100 percent modulation. In this condition the VOICE GAIN control on the transmitter should be set so that the A.C. METER shows a MODULATION level of 100 volts.

c. A good operating check on the over-all adjustment is to note that if the operator talks in a normal voice, the MODULATION reading on the transmitter is between 50 and 100 volts and the LINK CURR. reading rarely kicks up. *An upward movement of the LINK CURR. with modulation indicates over-modulation.*

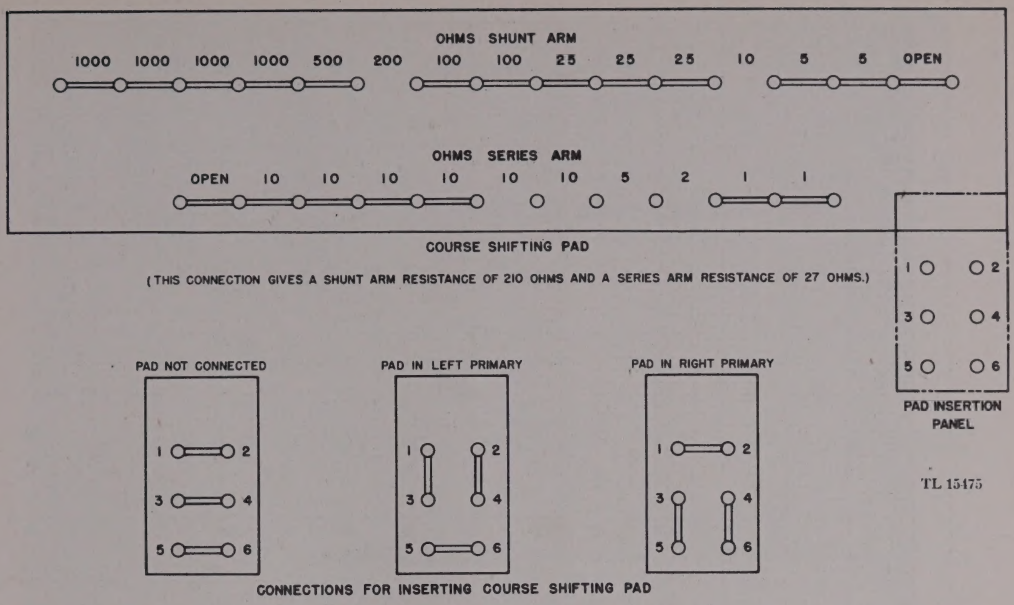

OHMS SHUNT ARM
1000 1000 1000 1000 500 200 100 100 25 25 25 10 5 5 OPEN
OHMS SERIES ARM
OPEN 10 10 10 10 10 10 5 2 1 1
COURSE SHIFTING PAD
(THIS CONNECTION GIVES A SHUNT ARM RESISTANCE OF 210 OHMS AND A SERIES ARM RESISTANCE OF 27 OHMS.)
1 2
3 4
5 6
PAD INSERTION PANEL
TL 15475
PAD NOT CONNECTED
PAD IN LEFT PRIMARY
PAD IN RIGHT PRIMARY
CONNECTIONS FOR INSERTING COURSE SHIFTING PAD

Figure 27. Course shifting L pad connections.

19. FINAL SETTING OF TONE LEVEL

a. With transmitter returned to normal range operation (microphone tab not depressed) advance the TONE GAIN control until the LINK CURR. reading starts to increase. Note the A.C. METER reading (approximately 115 volts) and reduce it 10 volts by backing off the TONE GAIN control. This will set modulation at approximately 90 percent. During normal operation leave A.C. METER SWITCH in FIL. position. If left in MOD. position to measure modulation, some of the switching operations may burn out the meter because of transient voltage surges.

20. RECORDING READINGS AND FINAL ADJUSTMENTS

a. When all adjustments are completely satisfactory, enter all readings on the chart cards provided on the front panel, including the signature of the operator as well as the date. Compare with the data shown in the charts of normal meter readings, section IV, paragraphs 47 and 48.

b. Make sure all dials are locked. For remote control using Remote Control RM-45-A, the LOCAL-REMOTE switch is left in REMOTE position, and the PLATE and MAIN POWER switches are left ON. The FILAMENT switch has no effect and may be left OFF. The KEYER switch must be left ON.

21. INDICATIONS OF NORMAL OPERATION

a. When the transmitter has been installed and all adjustments have been made as directed, FILAMENT pilot P1 (green) and PLATE pilot P2 (red) on the transmitter will be lit. LINE pilot P1R (amber) and RANGE pilot P3R (green) on the remote control unit will be lit.

b. The keyer will be operating.

c. The link circuit relay E2 will be operating in accordance with the keying pattern.

d. The quarter-phasing relay E11 will operate when the PRESS TO TALK switch is closed on the microphone.

e. The VOICE pilot P2R (red) on the remote control unit will light when the PRESS TO TALK tab on the microphone is closed.

f. The voice-audio switchover relay E10 will operate when the PRESS TO TALK tab on the microphone is closed.

g. During the cycle of identification keying, the A.C. METER M2 when on MOD. position will fluctuate between zero and about 115 volts.

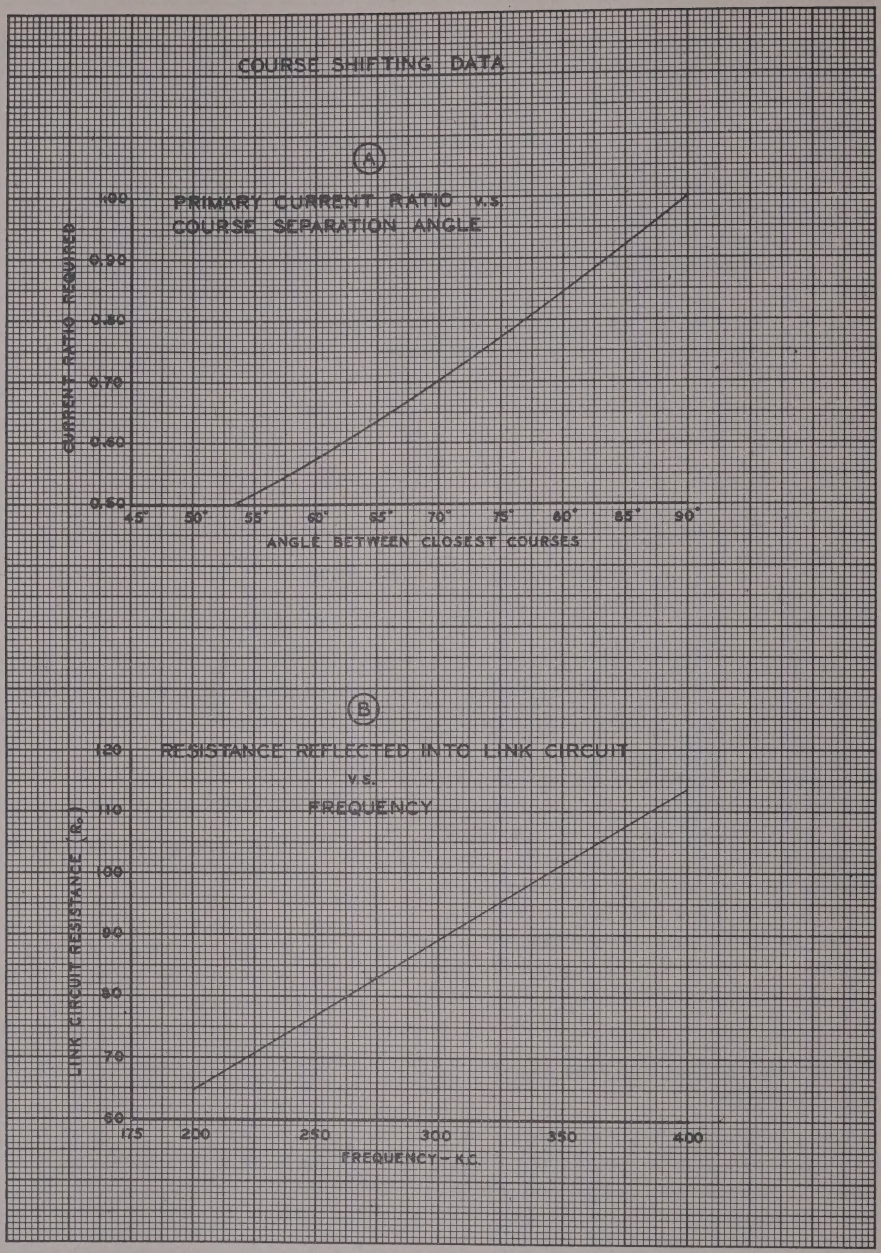


Figure 28. Course shifting data: current ratio and R_O.

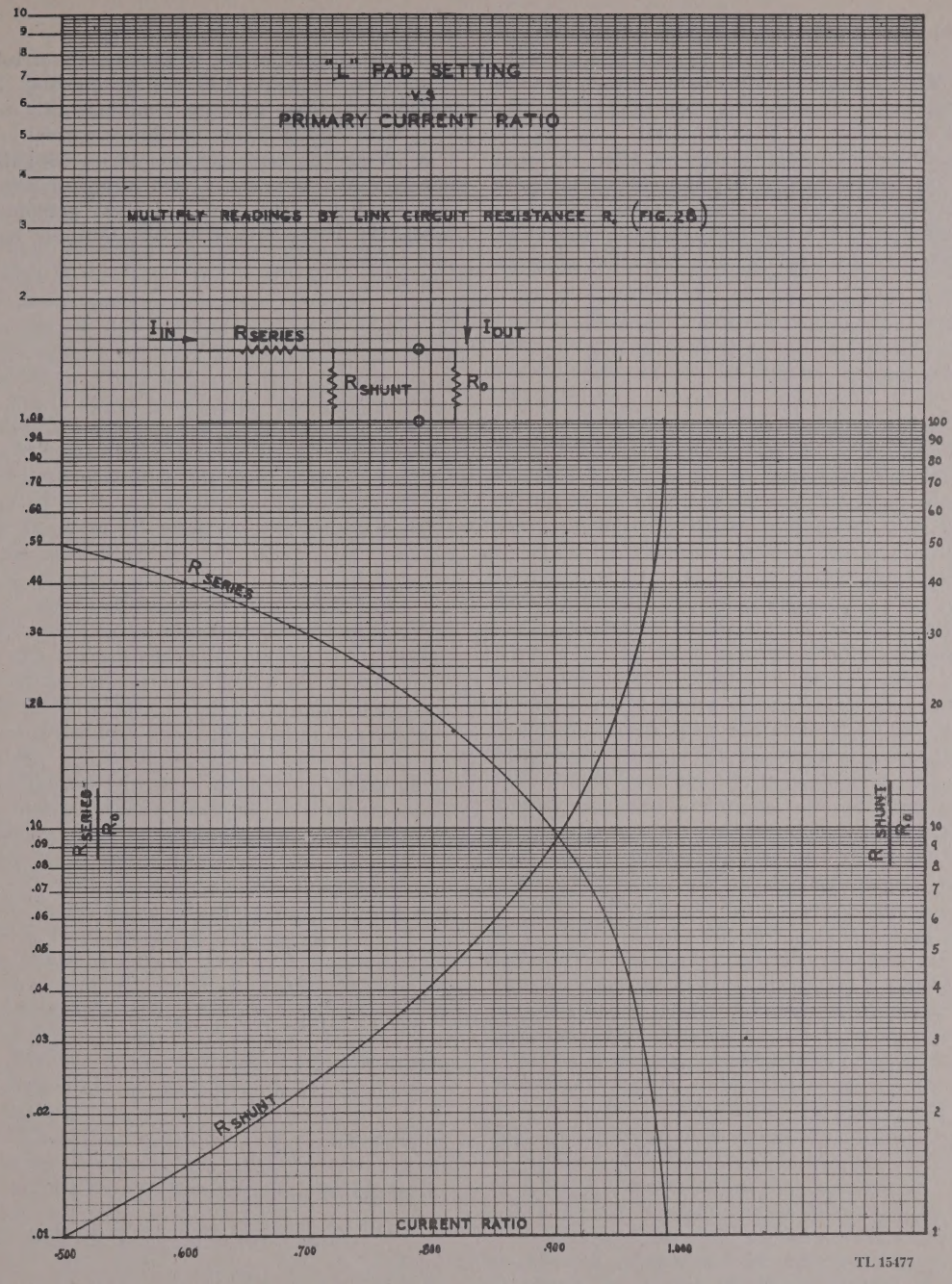


Figure 29. Course shifting L pad calibration chart.

h. During voice operation with normal voice input to the microphone, the A.C. METER M2 when on MOD. position will fluctuate between zero and a maximum value less than 100 volts.

i. Variation in VOICE GAIN and TONE GAIN control position should not affect the value of the link current or left and right goniometer secondary currents unless over-modulation is present, in which case there may be a small rise. This may be used as an indication of over-modulation.

j. One or more of the voltage regulator tubes V14, V15, V16, and V17 will be glowing. The number of tubes glowing simultaneously may vary with keying. This variation is normal.

k. When the goniometer is set at 45°, 135°, 225°, or 315° and the L pad is out of circuit, the readings of the left and right goniometer secondary currents will be substantially equal and constant.

Section III

FUNCTIONING OF PARTS

22. REPACKING TRANSMITTER FOR SHIPMENT

a. Place the transmitter on the wooden skid and bolt at each of the four corners. When the packing is completed, this skid becomes the bottom of the packing case.

b. Tie all tube cap leads and all large ferrule type resistors securely. Bring the tie out to a knob on the front of the transmitter to prevent the possibility of overlooking the tie when the transmitter is set up for operation.

c. Wedge relay E11 upward with cardboard. Tie the cardboard to the door so that it will be removed when the door is opened.

d. Place the following items in a cloth bag and tie the bag into the oil drip pan:

(1) Six extra fuses
(2) Two heater elements for E3
(3) One bottle of oil and a funnel

e. Tie the bag which contains the extra identification switch segments to the keyer motor. Replace the envelopes containing the technical manuals and test data on the front of the transmitter (fig. 8).

f. Nail the two sides and the top of the packing case together. Cover the 2 x 3 inch cross members with wadding to prevent damage to the finish of the transmitter.

g. Cover the transmitter entirely with a waterproof paper. Lower in place and nail the side and top assembly of the packing case.

h. Cover the 2 x 4 inch cross members with wadding and nail in place across the front of the transmitter at the top and under the switch panel.

i. Place and nail the remaining 2 x 4 inch cross members across the back at the top and the bottom.

j. When the front and rear of the packing cases are nailed correctly, place two steel bands around the case at the top and just below the center.

k. Tack all packing slips to the case.

23. THEORY OF RADIO RANGE

a. Purpose. The standard radio range establishes four straight-line courses or aerial paths directed radially from the station locations (fig. 2). The courses are lines along which an unbroken tone signal is received. These courses are separated by regions or quadrants in which either the letter A or N is received, the A and N quadrants alternating around the compass. Radio Transmitter BC-446-J can be adjusted to produce any combination of four reciprocal courses subtending angles of not less than 53° nor any more than 127°.

b. Radiation Patterns. The horizontal radiation pattern of a vertical loop antenna is a figure-8 with the nulls broadside to the loop (fig. 30A). The horizontal radiation pattern of the two vertical antennas excited with equal currents 180° out of phase (sometimes called a "grounded Adcock") is identical with that of the loop. In fact the only useful portions of the loop are the two vertical elements. The horizontal portions merely serve to feed the vertical sections with equal currents, 180° out of phase. If the two loops are placed at right angles to each other and alternately energized, they will alternately establish figure-8 patterns at right angles to each other (fig. 30B). If the loops are *alternately* energized with interlocked A and N characters, so that a mark on one loop is a space on the other, a continuous tone will be received on the lines 45° from the loops where the loops supply signals of equal intensity. Moving off these lines, either an A or N signal will predominate (fig. 30). Had one loop been fed less current than the other, the lines of equal signal from each loop would have been shifted or squeezed closer to the plane of the weaker loop (fig. 30C).

c. Course Setting. (1) The radio range system described foregoing will establish courses fixed in position by the physical position of the loops. The goniometer, based on the following theory, permits setting of the courses at any desired horizontal position independent of the loop position.

(2) Two right angle crossed loops, *simultaneously* energized by equal currents in phase, will establish a figure-8 pattern with nulls on lines 45° from the planes of the loops (fig. 31A). If the current is gradually increased in one loop and decreased in the other, the pattern will remain a figure-8 but will rotate toward the plane

of the stronger loop (fig. 31B). It can be shown mathematically that the pattern assumes an angle, with respect to the loops, whose trigonometric tangent is the ratio of the currents in the loops.

d. Goniometer. (1) The goniometer by which the loops are fed is a device to set the pattern at any desired angle by varying the relative currents. The goniometer consists of two series resonated primaries, wound at right angles to each other on a rotor structure, and two series resonated secondaries, also at right angles to each other on the stator. The design of the goniometer is such that the mutual inductance between each primary and each secondary varies as the sine of the angle of rotation between them (fig. 32). Each primary induces voltage in both secondaries, the position of the primary determining the relative amplitude of the induced voltage and resulting current in each secondary. Hence, if the secondaries are each connected to one of the crossed loops, and one primary is energized, a figure-8 pattern will be established at the same angles with respect to the loops as the goniometer primary makes with the secondaries (figs. 31 and 32).

(2) If the energizing current is shifted to the other primary, the identical pattern will be set up, but shifted 90° in position, since the primaries are 90° apart (fig. 33). If the goniometer primaries are now alternately energized with interlocked A and N characters, four courses will be established which can be rotated in space by rotating the goniometer. If an attenuating pad is inserted in one primary, the courses will be shifted or squeezed toward the angular position of that primary.

24. THEORY OF VOICE BROADCAST

a. Since each loop or each pair of towers can only give a figure-8 field pattern, they are individually unsuited for voice broadcast, inasmuch as an airplane might be located on a radiation null at the time of broadcast. Similarly, as shown in the preceding paragraph, two loops or pairs of towers, fed simultaneously in phase will still give a figure-8 pattern. However, if the loops are simultaneously excited 90° out of phase with each other, the over-all radiation pattern will be circular. Since the patterns from the two loops are 90° out of phase, they can never subtract from each other and produce nulls.

b. The method of exciting the loops 90° out of phase is to excite the goniometer primaries 90° out of phase. This establishes a so-called "synchronous rotating field" in the goniometer. The secondaries, which are located 90 mechanical degrees apart will be excited 90 electrical degrees apart. (The operation of this can be easily visualized with the goniometer on 0°, 90°, 180° or 270°. It can also be shown mathematically to be true at any goniometer position.) The primaries are excited 90° out of phase by inserting a proper value of inductance in series with one primary and a proper value of capacitance in series with the other primary. If the load resistance reflected into each of the goniometer primaries from the secondaries is R_0, and the reactances are numerically equal to R_0, the current in one will lag 45° and the current in the other will lead 45°, placing them 90° apart. If the two primary circuits are then placed in parallel, the reactance in each circuit being equal and opposite, will cancel, and the resulting parallel load impedance for the link circuit will still be R_0. The course shifting pad is, of course, removed from the circuit.

25. R-F VACUUM TUBE CIRCUITS

a. General. The radio frequency vacuum tube circuits are conventional, and differ little from those used in many other intermediate frequency transmitters. A block diagram of Radio Transmitter BC-446-J is shown in figure 34. The schematic diagram is shown in figure 35.

b. Crystal Oscillator. The crystal oscillator V1 is a JAN-807 tetrode operated in a conventional tuned plate circuit (fig. 36). Switch S1 serves to select CR1 or CR2. These crystals are normally on the same frequency, one serving as a spare. Cathode bias is supplied by R2 bypassed by C1, and automatic grid leak bias is developed across R1. Fixed screen voltage of approximately 150 volts is supplied from the auxiliary plate rectifier voltage divider. The plate is shunt fed by the high impedance primary of L1 with approximately 250 volts from the auxiliary plate rectifier voltage divider. The voltage drop across R55, which is in series with the plate lead is used to meter plate current. Parasitic suppressor G1 (a small r-f choke, wound around, and connected in parallel with a carbon resistor) is connected directly in the plate lead, since JAN-807 tubes have a tendency towards spurious very high-frequency oscillation. The plate output is coupled to the low impedance secondary of L1 by both capacitive and inductive coupling, C3 being used as coupling capacitor. The secondary of L1 is tuned by variable capacitor C5 (CRYSTAL TUNING dial).

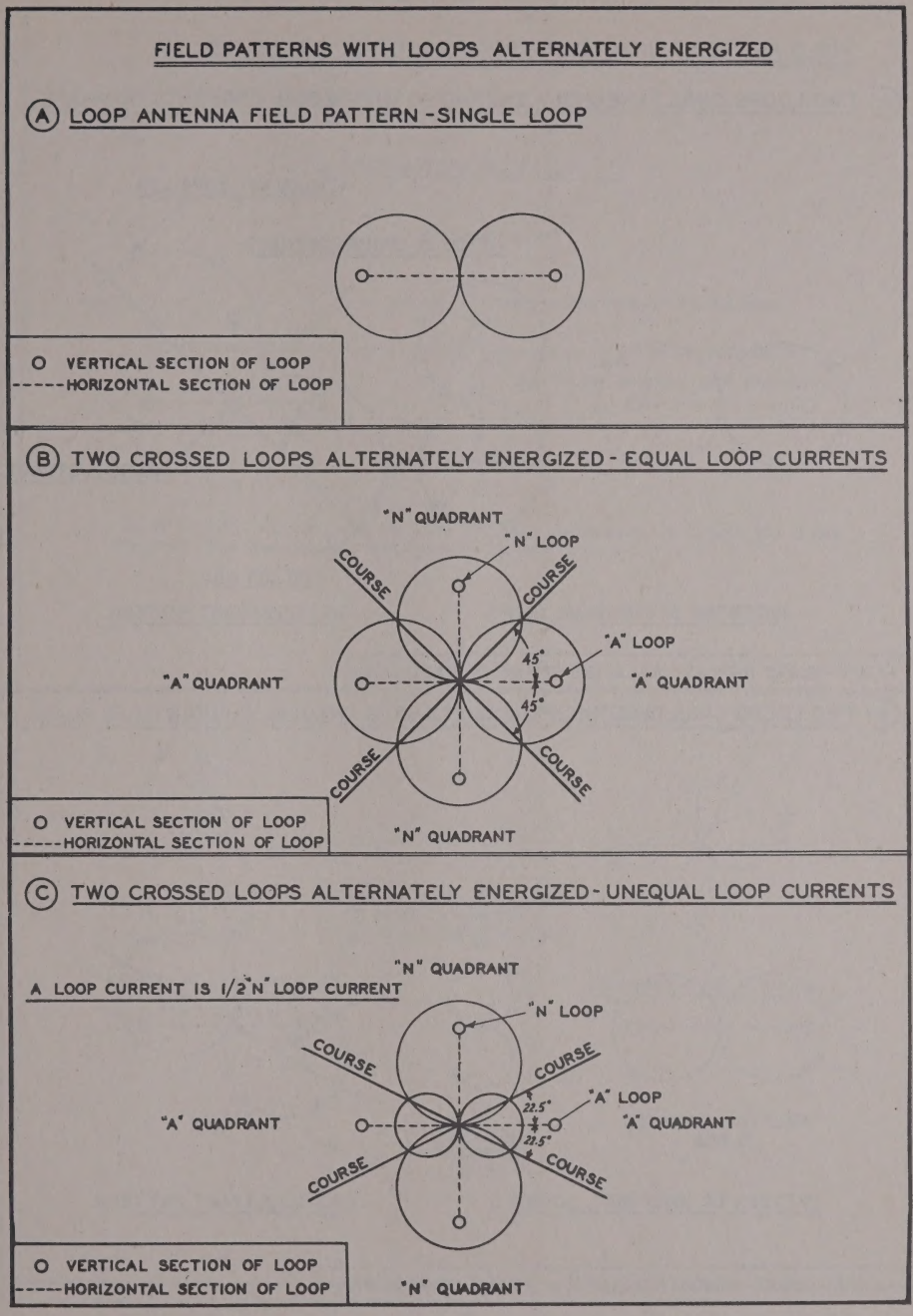
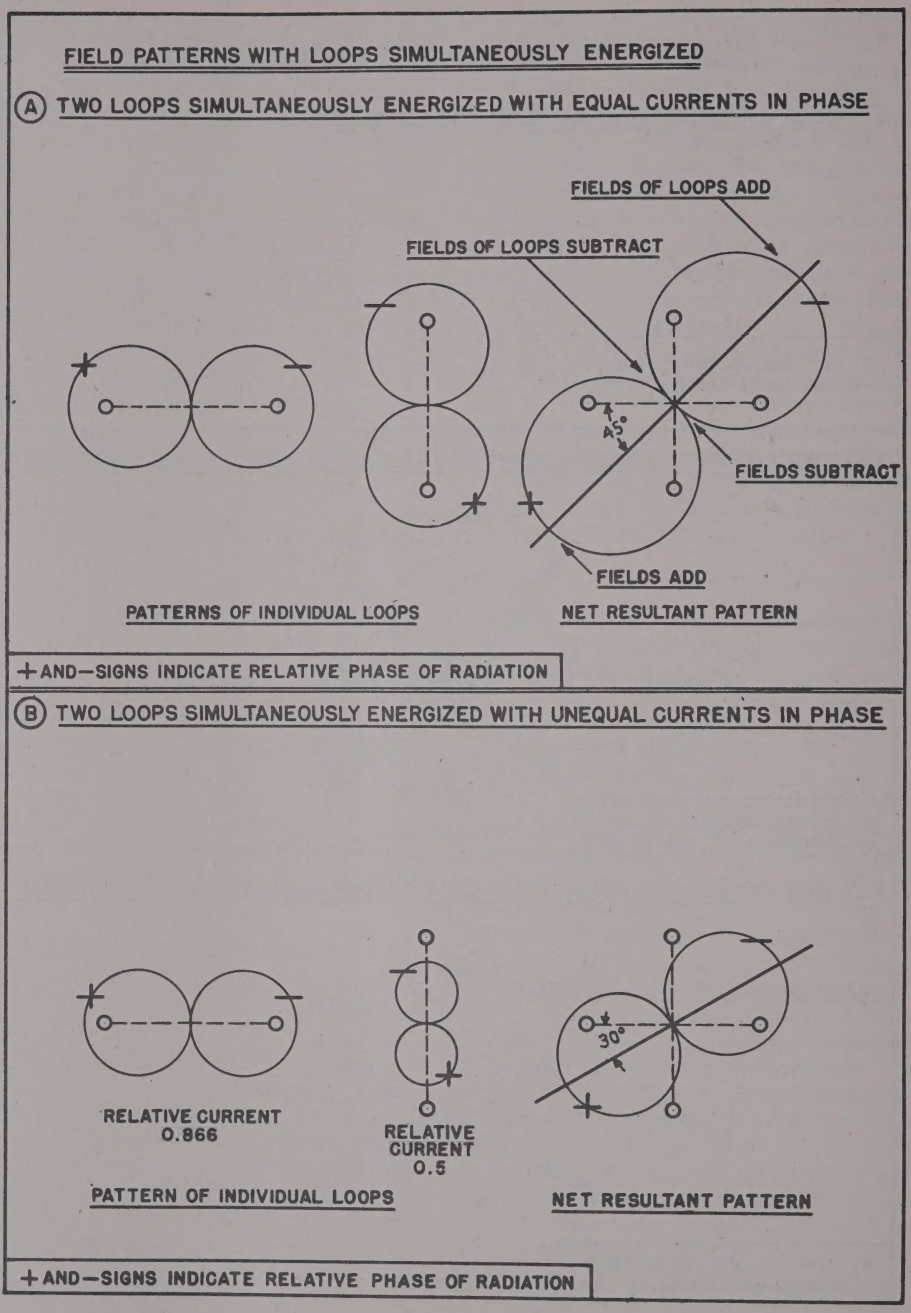


Figure 30. Theory of radio range, field patterns with loops alternately energized.


FIELD PATTERNS WITH LOOPS SIMULTANEOUSLY ENERGIZED
A TWO LOOPS SIMULTANEOUSLY ENERGIZED WITH EQUAL CURRENTS IN PHASE
FIELDS OF LOOPS ADD
FIELDS OF LOOPS SUBTRACT
45°
FIELDS SUBTRACT
FIELDS ADD
PATTERNS OF INDIVIDUAL LOOPS
NET RESULTANT PATTERN
+AND—SIGNS INDICATE RELATIVE PHASE OF RADIATION
B TWO LOOPS SIMULTANEOUSLY ENERGIZED WITH UNEQUAL CURRENTS IN PHASE
RELATIVE CURRENT 0.866
RELATIVE CURRENT 0.5
30°
PATTERN OF INDIVIDUAL LOOPS
NET RESULTANT PATTERN
+AND—SIGNS INDICATE RELATIVE PHASE OF RADIATION

TL 15179

Figure 31. - Theory of radio range, field patterns with loops simultaneously energized.

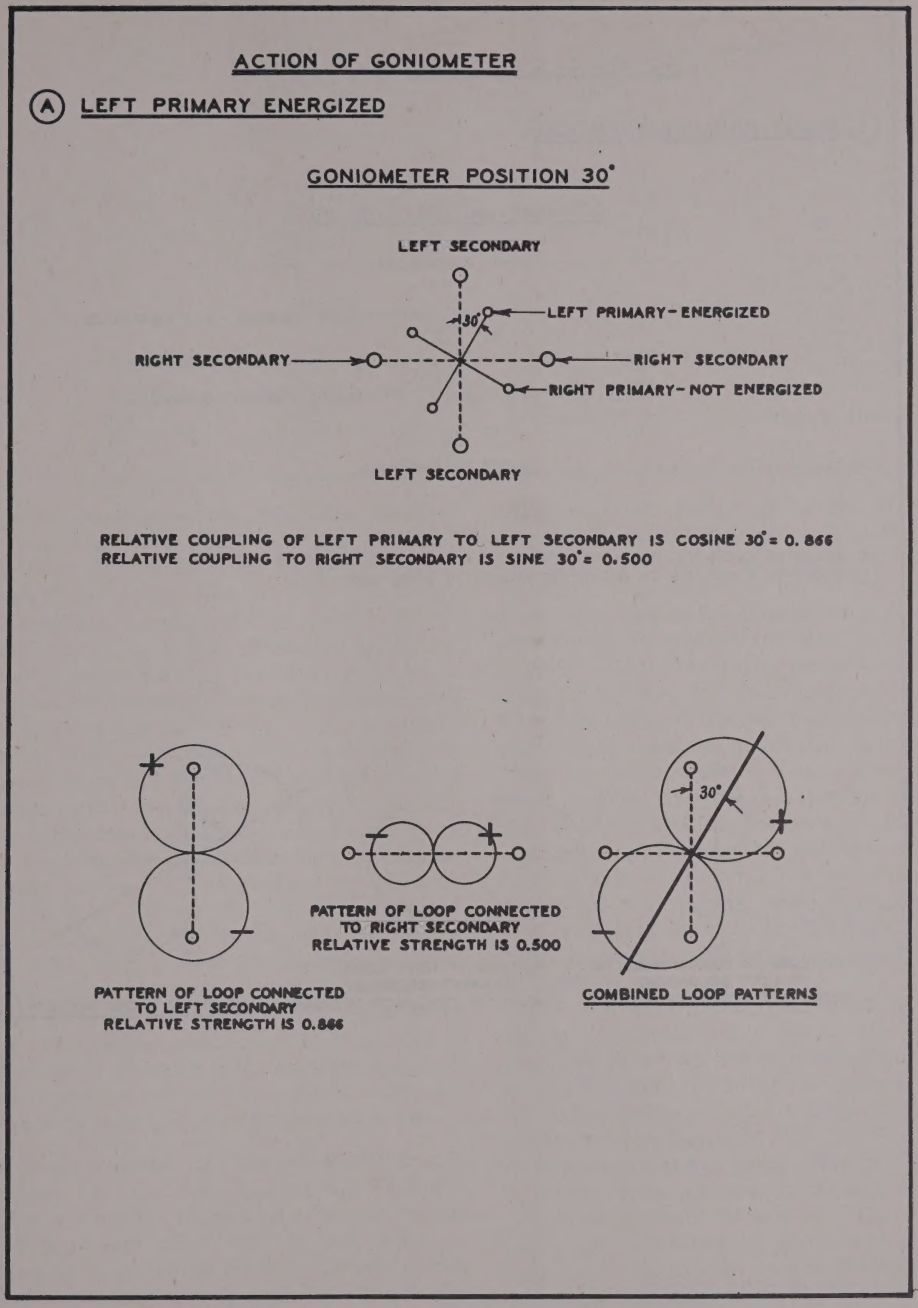
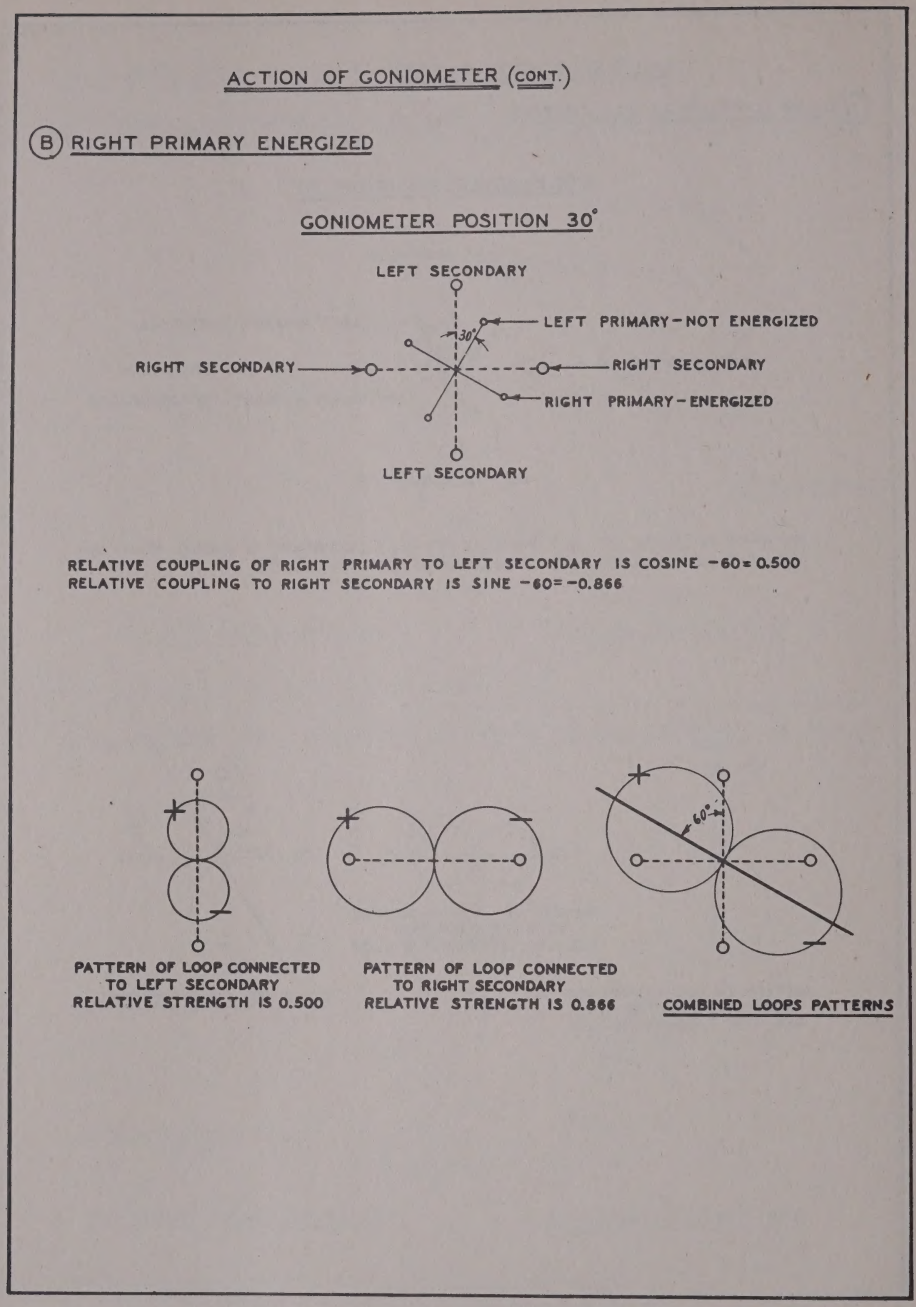

ACTION OF GONIOMETER
A LEFT PRIMARY ENERGIZED
GONIOMETER POSITION 30°
LEFT SECONDARY
30°
LEFT PRIMARY - ENERGIZED
RIGHT SECONDARY
RIGHT SECONDARY
RIGHT PRIMARY - NOT ENERGIZED
LEFT SECONDARY
RELATIVE COUPLING OF LEFT PRIMARY TO LEFT SECONDARY IS COSINE 30° = 0.866
RELATIVE COUPLING TO RIGHT SECONDARY IS SINE 30° = 0.500
PATTERN OF LOOP CONNECTED TO LEFT SECONDARY RELATIVE STRENGTH IS 0.866
PATTERN OF LOOP CONNECTED TO RIGHT SECONDARY RELATIVE STRENGTH IS 0.500
30°
COMBINED LOOP PATTERNS
TL 15480

Figure 32. Theory of radio range, action of goniometer, left primary energized.


ACTION OF GONIOMETER (CONT.)
(B) RIGHT PRIMARY ENERGIZED
GONIOMETER POSITION 30°
LEFT SECONDARY
LEFT PRIMARY - NOT ENERGIZED
30°
RIGHT SECONDARY
RIGHT SECONDARY
RIGHT PRIMARY - ENERGIZED
LEFT SECONDARY
RELATIVE COUPLING OF RIGHT PRIMARY TO LEFT SECONDARY IS COSINE -60 = 0.500
RELATIVE COUPLING TO RIGHT SECONDARY IS SINE -60 = -0.866
60°
PATTERN OF LOOP CONNECTED TO LEFT SECONDARY RELATIVE STRENGTH IS 0.500
PATTERN OF LOOP CONNECTED TO RIGHT SECONDARY RELATIVE STRENGTH IS 0.866
COMBINED LOOPS PATTERNS

TL 15481

Figure 33. Theory of radio range, action of goniometer, right primary energized.

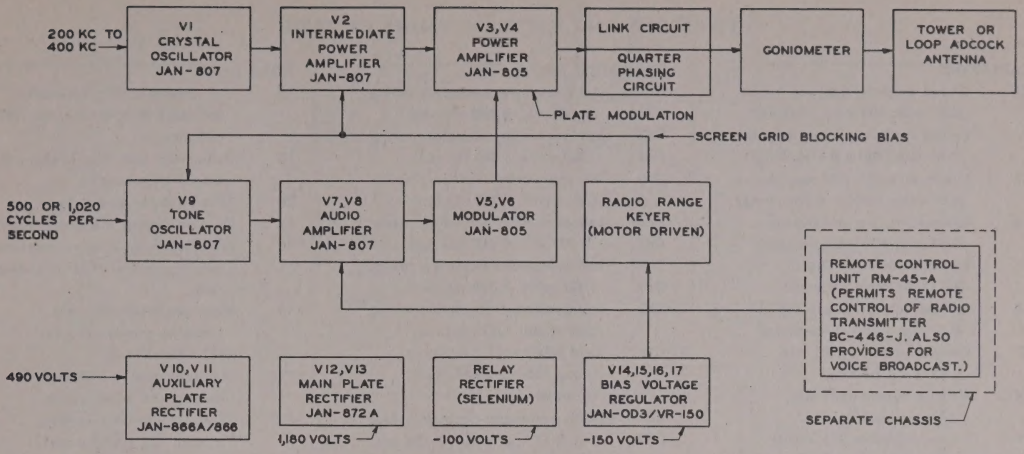

200 KC TO 400 KC
V1 CRYSTAL OSCILLATOR JAN-807
V2 INTERMEDIATE POWER AMPLIFIER JAN-807
V3,V4 POWER AMPLIFIER JAN-805
LINK CIRCUIT
QUARTER PHASING CIRCUIT
GONIOMETER
TOWER OR LOOP ADCOCK ANTENNA
PLATE MODULATION
SCREEN GRID BLOCKING BIAS
500 OR 1,020 CYCLES PER SECOND
V9 TONE OSCILLATOR JAN-807
V7,V8 AUDIO AMPLIFIER JAN-807
V5,V6 MODULATOR JAN-805
RADIO RANGE KEYER (MOTOR DRIVEN)
REMOTE CONTROL UNIT RM-45-A (PERMITS REMOTE CONTROL OF RADIO TRANSMITTER BC-446-J. ALSO PROVIDES FOR VOICE BROADCAST.)
490 VOLTS
V10,V11 AUXILIARY PLATE RECTIFIER JAN-866A/866
V12,V13 MAIN PLATE RECTIFIER JAN-872A
RELAY RECTIFIER (SELENIUM)
V14,15,16,17 BIAS VOLTAGE REGULATOR JAN-OD3/VR-150
1,180 VOLTS
-100 VOLTS
-150 VOLTS
SEPARATE CHASSIS

Figure 34. Radio Transmitter BC-446-J and Remote Control Unit RM-45-A, block diagram. TL 15403

c. Intermediate Power Amplifier. The intermediate power amplifier (ipa) is V2, a JAN-807 beam tetrode. The grid is capacity coupled through C3 from the preceding stage. The inductive coupling is negligible, L1 primary acting primarily as a shunt feed choke. Fixed bias of 150 volts is supplied from the bias voltage regulator bank and automatic bias is developed across R3. A blocking bias of 100 to 150 volts is applied to the screen from the relay rectifier, through isolating resistors R19 and R30. The stage is keyed by removing this voltage and applying screen voltage of approximately 250 volts from the auxiliary plate rectifier voltage divider through screen dropping resistor R5. The plate is fed with approximately 500 volts from the auxiliary plate rectifier through the high impedance primary of L2. Plate current is metered by measuring the voltage drop across R56. Parasitic suppressor G2 is used in the plate lead. The primary of L2 is inductively and capacitively coupled to the secondary, using C7 as the coupling capacitor. The secondary of L2 is center-tapped and the center tap is bypassed to ground potential by C8.

d. Power Amplifier. (1) The grids of the power-amplifier (p-a) tubes, V3 and V4, JAN-805 triodes, are excited in parallel from the bottom of L2 secondary, while the top end, which is at opposite r-f potential from the bottom is connected to the neutralizing capacitor C9. The secondary of L2 is tuned by variable capacitor C10 (I. P. A. TUNING dial) in parallel with padding capacitor C11. C11 is used to prevent the possibility of resonating the intermediate power amplifier at upper harmonics of the crystal frequency. The p-a tubes receive a fixed grid bias of 150 volts from bias voltage regulator bank plus automatic bias developed across R4. Parasitic suppressor resistor R6 is connected in the parallel grid circuit to prevent spurious very high-frequency oscillation in which the parallel p-a tubes could act as a very high-frequency push-pull oscillator. The plates of the p-a tubes are connected in parallel and shunt fed by X3 with approximately 1,200 d-c volts modulated coming from the main plate rectifier through the modulation transformer secondary. The p-a stage is metered by measuring the voltage drop across R57 which is connected in series with the filament winding center-tap return, thus measuring cathode current. The plate output of the p-a tubes is capacitively coupled through blocking capacitor C14 to the tank circuit.

(2) The tank capacitor consists of C15 and C16 for the band from 200 to 280 kc, and C15 alone from 280 to 400 kc. The inductive branch of the p-a tank consists of tuning variometer L3 (P. A. TUNING dial) in series with the primary (rotor) of variocoupler L4 (OUTPUT COUPLING dial) in series with fixed coupling inductor L15. Output is coupled from p-a tank by the sum of the coupling inductance of L4 and L15. The purpose in using L15 is to make the useful range of adjustment of L4 a full 180 mechanical degrees. The maximum coupling inductance of L4 is equal to the coupling inductance of L15. With OUTPUT COUPLING dial at 0, L4 is at maximum coupling, and the polarity of L4 coupling, is opposite to the

(Turn to Page 50)

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C1 Crystal oscillator cathode bypass (0.01 mfd, 600 v d-c working)
C2 Crystal oscillator screen bypass (0.01 mfd, 600 v d-c working)
C3 Intermediate p-a grid coupling (0.01 mfd, 1,200 v d-c working)
C4 Intermediate p-a grid bypass (0.01 mfd, 600 v d-c working)
C5 Crystal oscillator tuning (40-1,050 mmfd, variable)
C6 Intermediate p-a screen bypass (0.01 mfd, 600 v d-c working)
C7 P-a grid coupling (0.01 mfd, 1,200 v d-c working)
C8 P-a grid bypass (0.01 mfd, 600 v d-c working)
C9 P-a neutralization (16 mmfd)
C10 Intermediate p-a tuning (40-1,050 mmfd, variable)
C11 P-a grid padding (100 mmfd, 3,000 rms test)
C12, C13 P-a filament bypass (0.01 mfd, 600 v d-c working)
C14 P-a to link coupling (0.004 mfd, 5,000 rms test)
C15, C16 P-a tank (0.001 mfd, 8,000 rms test)
C17 Link circuit tuning (1,020 mmfd, variable)
C18 Link circuit tuning (500 mmfd, 5,000 rms test)
C19, C20 Link circuit tuning (0.001 mfd, 5,000 rms test)
C21 Not used
C22, C23 Auxiliary plate rectifier filter (6 mfd, 1,000 v d-c working)
C24, C25 Main plate rectifier filter (6 mfd, 2,000 v d-c working)
C26 Audio oscillator cathode bypass (4 mfd, 600 v d-c working)
C27, C28, C29 Relay rectifier filter (4 mfd, 600 v d-c working)
C30 Left goniometer primary tuning (1,020 mmfd, variable)
C31 Left goniometer primary tuning (500 mmfd, 5,000 rms test)
C32 Left goniometer primary tuning (0.001 mfd, 5,000 rms test)
C33, C34 Left goniometer primary tuning (0.002 mfd, 6,000 rms test)
C35 Right goniometer primary tuning (1,020 mmfd, variable)
C36 Right goniometer primary tuning (500 mmfd, 5,000 rms test)
C37 Right goniometer primary tuning (0.001 mfd, 5,000 rms test)
C38, C39 Right goniometer primary tuning (0.002 mfd, 6,000 rms test)
C40 Left goniometer secondary tuning (dual 40-540 mmfd, variable)

CAPACITORS (cont'd)

C41, C42 Left goniometer secondary tuning (0.001 mfd, 8,000 rms test)
C43, C44 Left goniometer secondary tuning (500 mmfd, 8,000 rms test)
C45 Left goniometer secondary tuning (250 mmfd, 8,000 rms test)
C46, C47 Left goniometer secondary tuning (0.001 mfd, 8,000 rms test)
C48, C49 Left goniometer secondary tuning (500 mmfd, 8,000 rms test)
C50 Left goniometer secondary tuning (250 mmfd, 8,000 rms test)
C51 Right goniometer secondary tuning (40-540 mmfd, dual, variable)
C52, C53 Right goniometer secondary tuning (0.001 mfd, 8,000 rms test)
C54, C55 Right goniometer secondary tuning (500 mmfd, 8,000 rms test)
C56 Right goniometer secondary tuning (250 mmfd, 8,000 rms test)
C57, C58 Right goniometer secondary tuning (0.001 mfd, 8,000 rms test)
C59, C60 Right goniometer secondary tuning (500 mmfd, 8,000 rms test)
C61 Right goniometer secondary tuning (250 mmfd, 8,000 rms test)
C62 Quarter-phasing (0.002 mfd, 1,200 v d-c working)
C63 Quarter-phasing (0.004 mfd, 1,200 v d-c working)
C64 Quarter-phasing (0.008 mfd, 1,200 v d-c working)
C65 Meter M1 bypass (0.01 mfd, 600 v d-c working)
C66 Audio oscillator tuning (0.022 mfd, 300 v d-c working)
C67, C68 Audio oscillator tuning (0.0375 mfd, 300 v d-c working)
C69 Tone filter (0.05 mfd, 300 v d-c working)
C70 Modulation meter M2 blocking (0.1 mfd, 2,000 v d-c working)
C71 Link circuit meter rectifier bypass (500 mmfd, 500 v d-c working)
C72 Left goniometer secondary meter rectifier bypass (500 mmfd, 500 v d-c working)
C73 Right goniometer secondary meter rectifier bypass (500 mmfd, 500 v d-c working)

COILS

L1 Crystal oscillator tank (pri. 4.7 millihenries; sec. 800 microhenries)
L2 P-a coupling (pri. 4.7 millihenries; sec. 620 microhenries)
L3 P-a plate variometer (90-290 microhenries)

COILS (cont'd)

L4 Link circuit coupling variometer (pri. 23.5 microhenries; sec. 185 microhenries)
L5 Goniometer (pri. 95 microhenries; sec. 35 microhenries)
L6 Tone oscillator tank (1 h)
L7 Quarter-phasing (88 microhenries)
L8 Left goniometer primary matching auto-transformer (420 microhenries)
L9 Right goniometer primary matching auto-transformer (420 microhenries)
L10 Left goniometer secondary loading (65 microhenries)
L11 Right goniometer secondary loading (65 microhenries)
L15 Link circuit fixed coupler (30 microhenries)
L16 Left goniometer primary loading (14 microhenries)
L17 Right goniometer primary loading (14 microhenries)
X1 Not used
X2 Not used
X3 P-a plate choke (15 millihenries)
X4 Main plate rectifier filter choke (6 h)
X5 Auxiliary plate rectifier filter choke (8 h)

CRYSTALS

CR1, CR2 Frequency control

FUSES

F1 Control circuit (3 amp)
F2 Control circuit (3 amp)
F3 Relay rectifier (1 amp)
F4 Relay rectifier (1 amp)
F5 Auxiliary plate rectifier (3 amp)
F6 Auxiliary plate rectifier (3 amp)
F7 Filament supply (5 amp)
F8 Filament supply (5 amp)
F9 Keyer motor (1 amp)
F10 Keyer motor (1 amp)
F11 Main plate rectifier (5 amp)
F12 Main plate rectifier (5 amp)
F13 D-c meter (1/100 amp)
F14 Blower motor (3 amp)
F15 Blower motor (3 amp)

HEATERS

H1 Tube V10 (100 w)
H2 Tube V11 (100 w)
H3 Tube V12 (100 w)
H4 Tube V13 (100 w)
H5 Crystal (2,000 ohms, 40 w)

METERS

M1 D-c meter (0-1 ma)
M2 A-c meter (0-150 v)

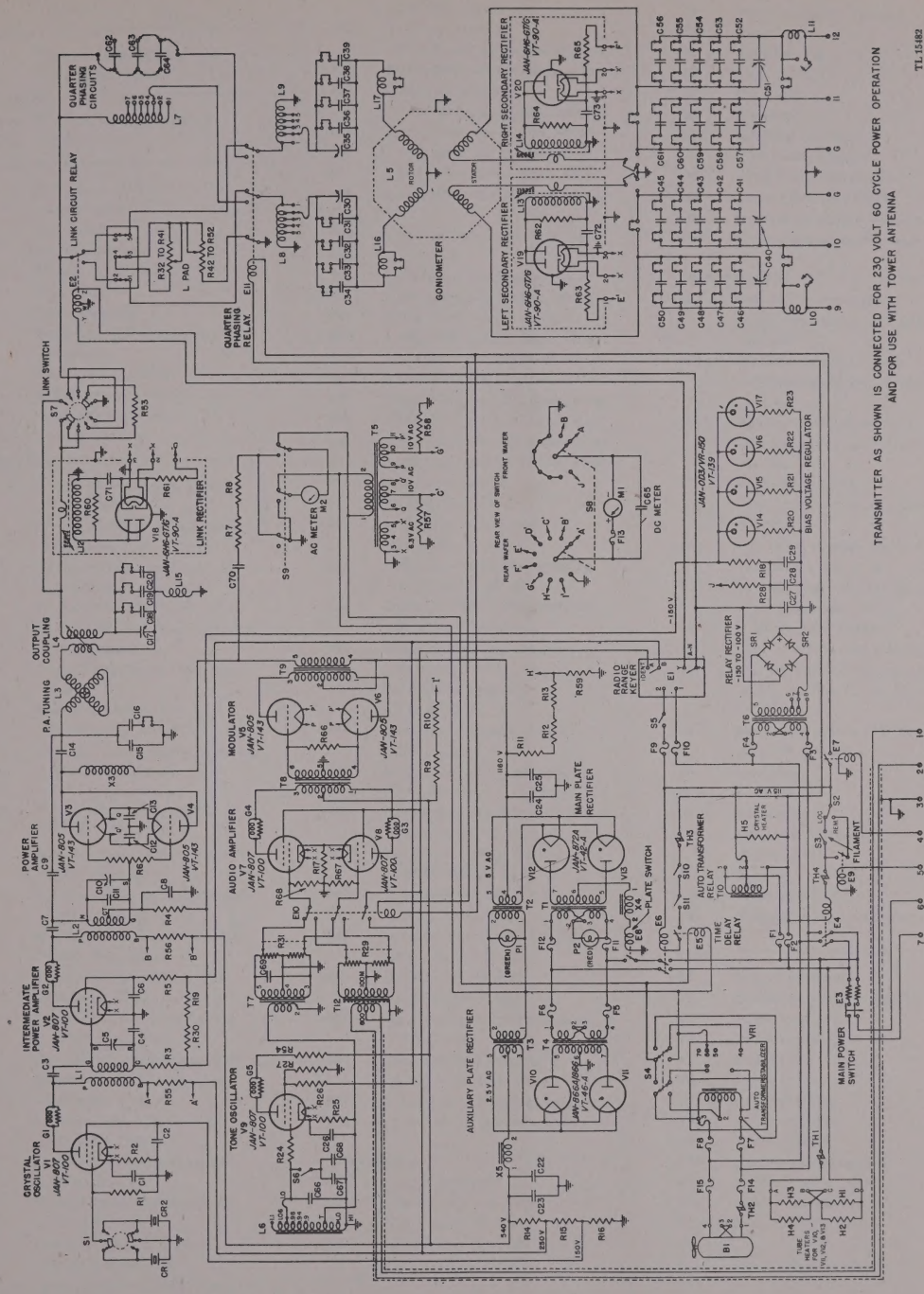


Figure 35. Radio Transmitter BC-446-J, schematic diagram.

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

MOTOR

B1	Blower (1.55 amp, 1/30 horsepower)

PILOTS

P1	Filament (6 w, 120 v)
P2	Plate (6 w, 120 v)

RECTIFIERS

SR1, SR2	Bias and relay (1/4 amp, 120 v d-c)

RELAYS

E1	A-N and identification signal keyer
E2	Link circuit
E3	Thermal overload
E4	Filament contactor
E5	Time delay
E6	Plate contactor
E7	Remote control voice-range switchover
E8	Main plate overload
E9	Remote power control
E10	Tone-voice switchover
E11	Quarter-phasing

RESISTORS

R1	Crystal oscillator grid bias (1 megohm, 2 w)
R2	Crystal oscillator cathode bias (400 ohms, 2 w)
R3	Intermediate p-a grid bias (25,000 ohms, 2 w)
R4	P-a grid bias (500 ohms, 60 w)
R5	Intermediate p-a screen dropping (3,000 ohms, 2 w)
R6	P-a grid suppressor (250 ohms, 40 w)
R7, R8	Modulation metering (50,000 ohms, 60 w)
R9, R10	Auxiliary plate rectifier metering (500,000 ohms, 2 w)
R11, R12, R13	Main plate rectifier bleeder (20,000 ohms, 60 w)
R14	Auxiliary plate rectifier bleeder (3,000 ohms, 60 w)
R15	Auxiliary plate rectifier bleeder (2,000 ohms, 60 w)
R16	Auxiliary plate rectifier bleeder (3,000 ohms, 60 w)
R17	Audio amplifier cathode bias (200 ohms, 20 w)
R18	Bias voltage regulator limiting (10,000 ohms, 2 w)
R19	Bias isolator (50,000 ohms, 2 w)
R20	Regulator tube V14 equalizer (500 ohms, 2 w)
R21	Regulator tube V15 equalizer (500 ohms, 2 w)
R22	Regulator tube V16 equalizer (500 ohms, 2 w)
R23	Regulator tube V17 equalizer (500 ohms, 2 w)
R24	Audio oscillator grid limiter (100,000 ohms, 2 w)
R25	Audio oscillator cathode bias (1,000 ohms, 2 w)
R26, R27	Audio oscillator screen bleeder (25,000 ohms, 2 w)

RESISTORS (cont'd)

R28	Relay rectifier metering (250,000 ohms, 2 w)
R29	Voice gain control (50,000 dual potentiometer)
R30	Bias isolator (50,000 ohms, 2 w)
R31	Tone gain control (3,000 ohms, dual potentiometer)
R32	L pad series arm (1 ohm, 40 w)
R33	L pad series arm (1 ohm, 40 w)
R34	L pad series arm (2 ohms, 40 w)
R35	L pad series arm (5 ohms, 40 w)
R36 thru R41	L pad series arm (10 ohms, 40 w)
R42	L pad shunt arm (5 ohms, 40 w)
R43	L pad shunt arm (5 ohms, 40 w)
R44	L pad shunt arm (10 ohms, 40 w)
R45	L pad shunt arm (25 ohms, 40 w)
R46	L pad shunt arm (25 ohms, 40 w)
R47	L pad shunt arm (25 ohms, 40 w)
R48	L pad shunt arm (100 ohms, 40 w)
R49	L pad shunt arm (100 ohms, 40 w)
R50	L pad shunt arm (200 ohms, 40 w)
R51	L pad shunt arm (500 ohms, 40 w)
R52	L pad shunt arm (4,000 ohms, 40 w)
R53	Link circuit tuning load (10 ohms, 40 w)
R54	Audio oscillator plate dropping (5,000 ohms, 20 w)
R55	Crystal oscillator plate metering (50 ohms, 2 w)
R56	Intermediate p-a plate metering (10 ohms, 2 w)
R57	P-a cathode metering (5 ohms, 2 w)
R58	Modulator cathode metering (5 ohms, 2 w)
R59	Main plate rectifier metering (63 ohms, 2 w)
R60	Transformer L12 load (10,000 ohms, 2 w)
R61	Link circuit current metering (30,000 ohms, 2 w)
R62	Transformer L13 load (10,000 ohms, 2 w)
R63	Left antenna current metering (80,000 ohms, 2 w)
R64	Transformer L14 load (10,000 ohms, 2 w)
R65	Right antenna current metering (80,000 ohms, 2 w)
R66	Modulator grid loading (5,000 ohms, 20 w)
R67	Driver grid (1 megohm, 2 w)
R68	Driver grid (1 megohm, 2 w)

SUPPRESSORS

G1	Crystal oscillator
G2	Intermediate p-a plate
G3	Audio driver V8 plate
G4	Audio driver V7 plate
G5	Tone oscillator plate

SWITCHES

S1	Crystal selector
S2	Local remote

SWITCHES (cont'd)

S3	Filament
S4	Voltage regulator cut-out
S5	Keyer
S6	Tone frequency
S7	Link tuning
S8	D-c meter
S9	A-c meter
S10	Left door interlock
S11	Right door interlock
TH1	Tube heater thermostatic
TH2	Fan control thermostatic
TH3	Under-temperature thermostatic
TH4	Over-temperature thermostatic

TRANSFORMERS

L12	Link circuit current (pri. 5 microhenries; sec. 13 millihenries)
L13	Left antenna current (pri. 5 microhenries; sec. 13 millihenries)
L14	Right antenna current (pri. 5 microhenries; sec. 13 millihenries)
T1	Main plate rectifier (pri. 115-230 v; sec. 1,500-0-1,500 v)
T2	Main plate rectifier filament (pri. 115 v; sec. 5 v)
T3	Auxiliary plate rectifier filament (pri. 115 v; sec. 2.5 v)
T4	Auxiliary plate rectifier (pri. 115-230 v; sec. 625-0-625 v)
T5	Filament (pri. 115 v; sec. No. 1 6.3 v; sec. No. 2 10 v; sec. No. 3 10 v)
T6	Relay rectifier (pri. 115-230 v; sec. 100-120-140 v)
T7	Tone input
T8	Audio driver
T9	Modulation
T10	Relay auto-transformer (230-115 v)
T11	Not used
T12	Voice input
VR1	Filament voltage regulator

TUBES

V1	Crystal oscillator
V2	Intermediate power amplifier
V3	Power amplifier
V4	Power amplifier
V5	Modulator
V6	Modulator
V7	Audio amplifier
V8	Audio amplifier
V9	Audio oscillator
V10	Auxiliary plate rectifier
V11	Auxiliary plate rectifier
V12	Main plate rectifier
V13	Main plate rectifier
V14 thru V17	Bias voltage regulator
V18	Link circuit meter rectifier
V19	Left goniometer meter rectifier
V20	Right goniometer meter rectifier

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fixed coupling provided by L15, so that the net coupling is 0. As the OUTPUT COUPLING dial is rotated upward from 0, the coupling from L4 drops until it is 0 at 50 on the dial and the total coupling is that due to L15 alone. As the dial setting is increased past 50, the coupling of L4 increases again, but with opposite or aiding polarity, until at a dial setting of 100, the total coupling is twice that of L15.

26. LINK CIRCUIT

a. The link circuit (fig. 37) is the series-resonated 50 to 120 ohm circuit used to couple the p-a tank to the goniometer primaries. It is used to operate the link circuit relay E2 at optimum current and voltage. The circuit consists of fixed coupling inductor L15, resonating capacitors C17, C18, C19, and C20, the secondary (stator) of L4 feeding the common arm of the link circuit relay E2 and auto-transformer L8 or L9. The capacitors serve to resonate the circuit, C17 being driven by the LINK TUNING dial.

b. LINK SWITCH S7 is used to facilitate tuning the various circuits, and current transformer L12 in conjunction with rectifier V18 serves to meter the link current. With the LINK SWITCH S7 in the extreme left or LINK TUNE position, the top of L4 secondary is in series with the L12 primary which is connected through non-inductive resistor R53 to ground. This connection permits resonating the link circuit alone, with R53 serving as a protective resistor to limit resonant current in the unloaded circuit. In the next position (GONIO TUNE) the output of L4 passes through the current transformer in series with R53 and into the link circuit relay, which connects it to one of the goniometer primaries. This position is used for tuning the goniometer, R53 still serving as protective resistor. In the third position (READ) S7 connects the output of L4 through the current transformer and directly into link circuit relay. This position is normally used when metering LINK CURRENT in normal operation after the equipment is tuned and loaded. The final position of S7 (OUT) is the same as the third, except that the current transformer is removed from the circuit. This position is used when the transmitter is operated unattended to protect the current transformer from surges.

c. The link circuit relay E2 is a single-pole, double-throw relay, used to switch the goniometer primaries in the A-N interlock sequence. It is constructed so as to be capable of very fine contact adjustment. Refer to paragraph 45.

27. GONIOMETER PRIMARIES

a. The goniometer primaries (fig. 38) are series-resonated by capacitor banks C30 to C34 (left primary) and C35 to C39 (right primary). C30 is coupled to the left PRIMARY TUNING dial and C35 is coupled to the right PRIMARY TUNING dial. Primary loading inductors L16 and L17 are used at low frequencies for loop operation only. The series-resonated primary circuits are fed from the link circuit relay through primary matching auto-transformers L8 and L9. These transformers are used to step up the low resistance load presented by the goniometer primaries when the secondaries feed transmission lines, to the impedance level at which the link circuit operates. L8 and L9 are not used with loop antennas. (They are left connected across the goniometer input to simplify connections, but have no effect on the circuit because of their high inductance.) In the normal unenergized position of E11, the auto-transformers are fed through the course shifting pad selector panel from the link circuit relay. The pad selector panel permits inserting the pad in either primary circuit. Figure 39 is a simplified schematic diagram showing the L pad connected in the left goniometer primary. Figure 40 is a schematic diagram showing the L pad connected in the right goniometer primary.

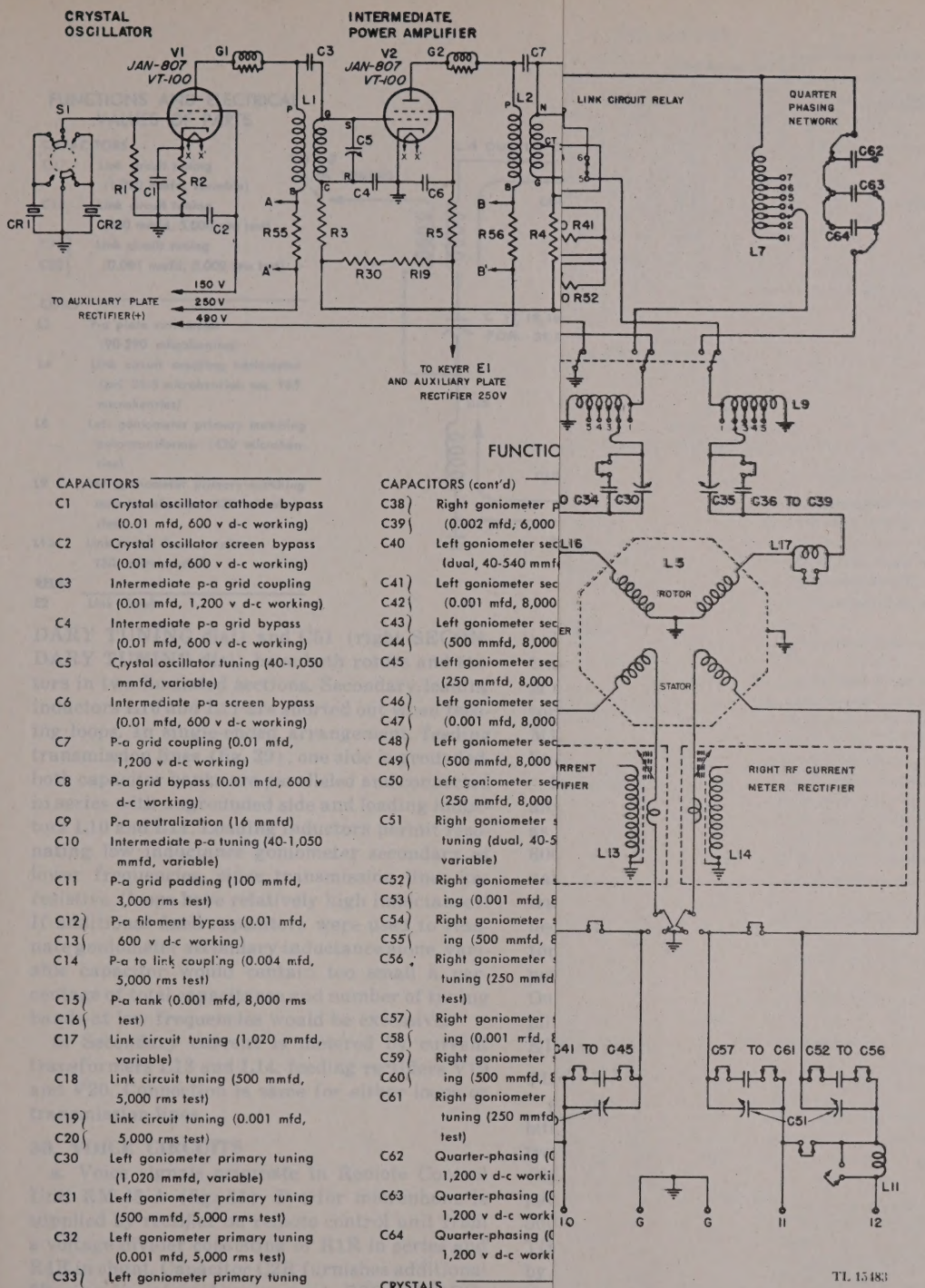
28. QUARTER-PHASING CIRCUITS

a. When the transmitter is thrown over to voice, the quarter-phasing relay E11 is energized. This relay disconnects the input to the primaries from the course shifting pad selector panel and connects them to the quarter-phasing inductor L7 and the quarter-phasing capacitor bank C62, C63, and C64. These reactances are energized directly from the common arm of E2. Another contact on E11 opens the ground return of the course shifting pad, completely removing the pad from the circuit.

b. The action of the quarter-phasing circuits is described in paragraph 24**b.**

29. GONIOMETER SECONDARY CIRCUITS

a. The goniometer secondaries may be connected either balanced to ground for feeding loops or with one side grounded for feeding concentric transmission lines. In the balanced arrangement, the capacitor banks are split and connected in series on both sides of the secondaries. Note that the variable units C40 (left SECON-



FUNCTIC

CAPACITORS

C1	Crystal oscillator cathode bypass (0.01 mfd, 600 v d-c working)
C2	Crystal oscillator screen bypass (0.01 mfd, 600 v d-c working)
C3	Intermediate p-a grid coupling (0.01 mfd, 1,200 v d-c working)
C4	Intermediate p-a grid bypass (0.01 mfd, 600 v d-c working)
C5	Crystal oscillator tuning (40-1,050 mmfd, variable)
C6	Intermediate p-a screen bypass (0.01 mfd, 600 v d-c working)
C7	P-a grid coupling (0.01 mfd, 1,200 v d-c working)
C8	P-a grid bypass (0.01 mfd, 600 v d-c working)
C9	P-a neutralization (16 mmfd)
C10	Intermediate p-a tuning (40-1,050 mmfd, variable)
C11	P-a grid padding (100 mmfd, 3,000 rms test)
C12, C13	P-a filament bypass (0.01 mfd, 600 v d-c working)
C14	P-a to link coupling (0.004 mfd, 5,000 rms test)
C15, C16	P-a tank (0.001 mfd, 8,000 rms test)
C17	Link circuit tuning (1,020 mmfd, variable)
C18	Link circuit tuning (500 mmfd, 5,000 rms test)
C19, C20	Link circuit tuning (0.001 mfd, 5,000 rms test)
C30	Left goniometer primary tuning (1,020 mmfd, variable)
C31	Left goniometer primary tuning (500 mmfd, 5,000 rms test)
C32	Left goniometer primary tuning (0.001 mfd, 5,000 rms test)
C33, C34	Left goniometer primary tuning (0.002 mfd, 6,000 rms test)
C35	Right goniometer primary tuning (1,020 mmfd, variable)
C36	Right goniometer primary tuning (500 mmfd, 5,000 rms test)
C37	Right goniometer primary tuning (0.001 mfd, 5,000 rms test)

CAPACITORS (cont'd)

C38, C39	Right goniometer p (0.002 mfd, 6,000
C40	Left goniometer sec (dual, 40-540 mmf
C41, C42	Left goniometer sec (0.001 mfd, 8,000
C43, C44	Left goniometer sec (500 mmfd, 8,000
C45	Left goniometer sec (250 mmfd, 8,000
C46, C47	Left goniometer sec (0.001 mfd, 8,000
C48, C49	Left goniometer sec (500 mmfd, 8,000
C50	Left goniometer sec (250 mmfd, 8,000
C51	Right goniometer s tuning (dual, 40-5 variable)
C52, C53	Right goniometer s ing (0.001 mfd, 8
C54, C55	Right goniometer s ing (500 mmfd, 8
C56	Right goniometer s tuning (250 mmfd test)
C57, C58	Right goniometer s ing (0.001 mfd, 8
C59, C60	Right goniometer s ing (500 mmfd, 8
C61	Right goniometer tuning (250 mmfd test)
C62	Quarter-phasing (0 1,200 v d-c worki
C63	Quarter-phasing (0 1,200 v d-c worki
C64	Quarter-phasing (0 1,200 v d-c worki

CRYSTALS

CR1, CR2	Frequency control

COILS

L1	Crystal oscillator to 4.7 millihenries; s microhenries)

re 36. R-f circuits, functional diagram.

fixed coupling provided by L15, so that the net coupling is 0. As the OUTPUT COUPLING dial is rotated upward from 0, the coupling from L4 drops until it is 0 at 50 on the dial and the total coupling is that due to L15 alone. As the dial setting is increased past 50, the coupling of L4 increases again, but with opposite or aiding polarity, until at a dial setting of 100, the total coupling is twice that of L15.

26. LINK CIRCUIT

a. The link circuit (fig. 37) is the series-resonated 50 to 120 ohm circuit used to couple the p-a tank to the goniometer primaries. It is used to operate the link circuit relay E2 at optimum current and voltage. The circuit consists of fixed coupling inductor L15, resonating capacitors C17, C18, C19, and C20, the secondary (stator) of L4 feeding the common arm of the link circuit relay E2 and auto-transformer L8 or L9. The capacitors serve to resonate the circuit, C17 being driven by the LINK TUNING dial.

b. LINK SWITCH S7 is used to facilitate tuning the various circuits, and current transformer L12 in conjunction with rectifier V18 serves to meter the link current. With the LINK SWITCH S7 in the extreme left or LINK TUNE position, the top of L4 secondary is in series with the L12 primary which is connected through non-inductive resistor R53 to ground. This connection permits resonating the link circuit alone, with R53 serving as a protective resistor to limit resonant current in the unloaded circuit. In the next position (GONIO TUNE) the output of L4 passes through the current transformer in series with R53 and into the link circuit relay, which connects it to one of the goniometer primaries. This position is used for tuning the goniometer, R53 still serving as protective resistor. In the third position (READ) S7 connects the output of L4 through the current transformer and directly into link circuit relay. This position is normally used when metering LINK CURRENT in normal operation after the equipment is tuned and loaded. The final position of S7 (OUT) is the same as the third, except that the current transformer is removed from the circuit. This position is used when the transmitter is operated unattended to protect the current transformer from surges.

c. The link circuit relay E2 is a single-pole, double-throw relay, used to switch the goniometer primaries in the A-N interlock sequence. It is constructed so as to be capable of very fine contact adjustment. Refer to paragraph 45.

27. GONIOMETER PRIMARIES

a. The goniometer primaries (fig. 38) are series-resonated by capacitor banks C30 to C34 (left primary) and C35 to C39 (right primary). C30 is coupled to the left PRIMARY TUNING dial and C35 is coupled to the right PRIMARY TUNING dial. Primary loading inductors L16 and L17 are used at low frequencies for loop operation only. The series-resonated primary circuits are fed from the link circuit relay through primary matching auto-transformers L8 and L9. These transformers are used to step up the low resistance load presented by the goniometer primaries when the secondaries feed transmission lines, to the impedance level at which the link circuit operates. L8 and L9 are not used with loop antennas. (They are left connected across the goniometer input to simplify connections, but have no effect on the circuit because of their high inductance.) In the normal unenergized position of E11, the auto-transformers are fed through the course shifting pad selector panel from the link circuit relay. The pad selector panel permits inserting the pad in either primary circuit. Figure 39 is a simplified schematic diagram showing the L pad connected in the left goniometer primary. Figure 40 is a schematic diagram showing the L pad connected in the right goniometer primary.

28. QUARTER-PHASING CIRCUITS

a. When the transmitter is thrown over to voice, the quarter-phasing relay E11 is energized. This relay disconnects the input to the primaries from the course shifting pad selector panel and connects them to the quarter-phasing inductor L7 and the quarter-phasing capacitor bank C62, C63, and C64. These reactances are energized directly from the common arm of E2. Another contact on E11 opens the ground return of the course shifting pad, completely removing the pad from the circuit.

b. The action of the quarter-phasing circuits is described in paragraph 24**b.**

29. GONIOMETER SECONDARY CIRCUITS

a. The goniometer secondaries may be connected either balanced to ground for feeding loops or with one side grounded for feeding concentric transmission lines. In the balanced arrangement, the capacitor banks are split and connected in series on both sides of the secondaries. Note that the variable units C40 (left SECON-

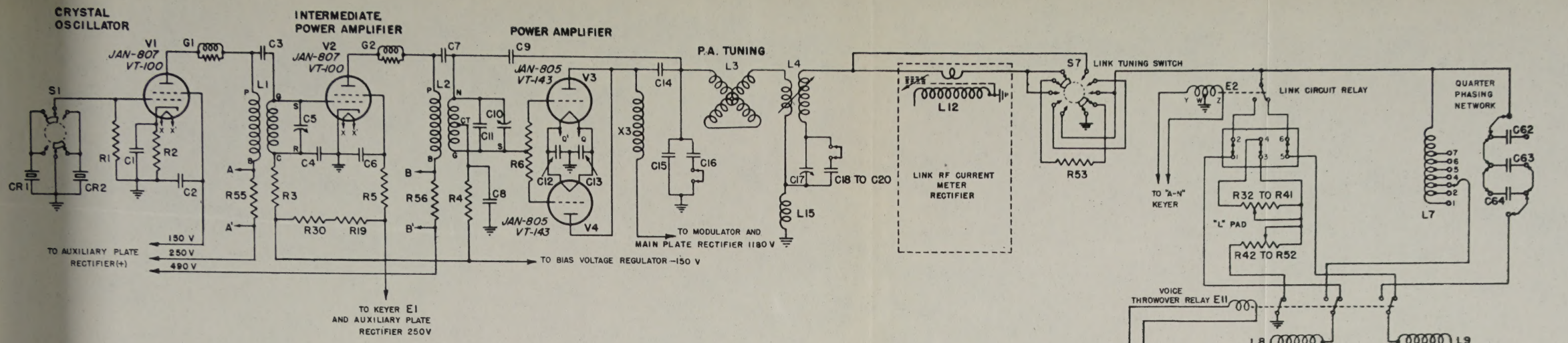


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Figure 36. R-f circuits, functional diagram.

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

- C1 Crystal oscillator cathode bypass (0.01 mfd, 600 v d-c working)
- C2 Crystal oscillator screen bypass (0.01 mfd, 600 v d-c working)
- C3 Intermediate p-a grid coupling (0.01 mfd, 1,200 v d-c working)
- C4 Intermediate p-a grid bypass (0.01 mfd, 600 v d-c working)
- C5 Crystal oscillator tuning (40-1,050 mmfd, variable)
- C6 Intermediate p-a screen bypass (0.01 mfd, 600 v d-c working)
- C7 P-a grid coupling (0.01 mfd, 1,200 v d-c working)
- C8 P-a grid bypass (0.01 mfd, 600 v d-c working)
- C9 P-a neutralization (16 mmfd)
- C10 Intermediate p-a tuning (40-1,050 mmfd, variable)
- C11 P-a grid padding (100 mmfd, 3,000 rms test)
- C12, C13 P-a filament bypass (0.01 mfd, 600 v d-c working)
- C14 P-a to link coupling (0.004 mfd, 5,000 rms test)
- C15, C16 P-a tank (0.001 mfd, 8,000 rms test)
- C17 Link circuit tuning (1,020 mmfd, variable)
- C18 Link circuit tuning (500 mmfd, 5,000 rms test)
- C19, C20 Link circuit tuning (0.001 mfd, 5,000 rms test)
- C30 Left goniometer primary tuning (1,020 mmfd, variable)
- C31 Left goniometer primary tuning (500 mmfd, 5,000 rms test)
- C32 Left goniometer primary tuning (0.001 mfd, 5,000 rms test)
- C33, C34 Left goniometer primary tuning (0.002 mfd, 6,000 rms test)
- C35 Right goniometer primary tuning (1,020 mmfd, variable)
- C36 Right goniometer primary tuning (500 mmfd, 5,000 rms test)
- C37 Right goniometer primary tuning (0.001 mfd, 5,000 rms test)

CAPACITORS (cont'd)

- C38, C39 Right goniometer primary tuning (0.002 mfd, 6,000 rms test)
- C40 Left goniometer secondary tuning (dual, 40-540 mmfd, variable)
- C41, C42 Left goniometer secondary tuning (0.001 mfd, 8,000 rms test)
- C43, C44 Left goniometer secondary tuning (500 mmfd, 8,000 rms test)
- C45 Left goniometer secondary tuning (250 mmfd, 8,000 rms test)
- C46, C47 Left goniometer secondary tuning (0.001 mfd, 8,000 rms test)
- C48, C49 Left goniometer secondary tuning (500 mmfd, 8,000 rms test)
- C50 Left goniometer secondary tuning (250 mmfd, 8,000 rms test)
- C51 Right goniometer secondary tuning (dual, 40-540 mmfd, variable)
- C52, C53 Right goniometer secondary tuning (0.001 mfd, 8,000 rms test)
- C54, C55 Right goniometer secondary tuning (500 mmfd, 8,000 rms test)
- C56 Right goniometer secondary tuning (250 mmfd, 8,000 rms test)
- C57, C58 Right goniometer secondary tuning (0.001 mfd, 8,000 rms test)
- C59, C60 Right goniometer secondary tuning (500 mmfd, 8,000 rms test)
- C61 Right goniometer secondary tuning (250 mmfd, 8,000 rms test)
- C62 Quarter-phasing (0.002 mfd, 1,200 v d-c working)
- C63 Quarter-phasing (0.004 mfd, 1,200 v d-c working)
- C64 Quarter-phasing (0.008 mfd, 1,200 v d-c working)

CRYSTALS

- CR1, CR2 Frequency control

COILS

- L1 Crystal oscillator tank (pri. 4.7 millihenries; sec. 725 microhenries)
- L2 P-a coupling (pri. 4.7 millihenries; sec. 620 microhenries)
- L3 P-a plate variometer (90-920 microhenries)
- L4 Link circuit coupling variometer (pri. 23.5 microhenries; sec. 185 microhenries)
- L5 Goniometer (pri. 95 microhenries; sec. 35 microhenries)
- L7 Quarter-phasing (88 microhenries)
- L8 Left goniometer primary matching auto-transformer (420 microhenries)
- L9 Right goniometer primary matching auto-transformer (420 microhenries)
- L10 Left goniometer secondary loading (65 microhenries)
- L11 Right goniometer secondary loading (65 microhenries)
- L15 Link circuit fixed coupler (30 microhenries)
- L16 Left goniometer primary loading (14 microhenries)
- L17 Right goniometer primary loading (14 microhenries)
- X3 P-a plate choke (15 millihenries)

RELAYS

- E2 Link circuit
- E7 Remote control voice-range switch-over
- E11 Quarter-phasing

RESISTORS

- R1 Crystal oscillator grid bias (1 megohm, 2 w)
- R2 Crystal oscillator cathode bias (400 ohms, 2 w)
- R3 Intermediate p-a grid bias (25,000 ohms, 2 w)
- R4 P-a grid bias (500 ohms, 60 w)
- R5 Intermediate p-a screen dropping (3,000 ohms, 2 w)
- R6 P-a grid suppressor (250 ohms, 40 w)

RESISTORS (cont'd)

- R19 Bias isolator (50,000 ohms, 2 w)
- R30 Bias isolator (50,000 ohms, 2 w)
- R32 L pad series arm (1 ohm, 40 w)
- R33 L pad series arm (1 ohm, 40 w)
- R34 L pad series arm (2 ohms, 40 w)
- R35 L pad series arm (5 ohms, 40 w)
- R36 thru R41 L pad series arm (10 ohms, 40 w)
- R42 L pad shunt arm (5 ohms, 40 w)
- R43 L pad shunt arm (5 ohms, 40 w)
- R44 L pad shunt arm (10 ohms, 40 w)
- R45 L pad shunt arm (25 ohms, 40 w)
- R46 L pad shunt arm (25 ohms, 40 w)
- R47 L pad shunt arm (25 ohms, 40 w)
- R48 L pad shunt arm (100 ohms, 40 w)
- R49 L pad shunt arm (100 ohms, 40 w)
- R50 L pad shunt arm (200 ohms, 40 w)
- R51 L pad shunt arm (500 ohms, 40 w)
- R52 L pad shunt arm (4,000 ohms, 40 w)
- R53 Link circuit tuning load (10 ohms, 40 w)
- R55 Crystal oscillator plate metering (50 ohms, 2 w)
- R56 Intermediate p-a plate metering (10 ohms, 2 w)

SUPPRESSORS

- G1 Crystal oscillator
- G2 Intermediate p-a plate

SWITCHES

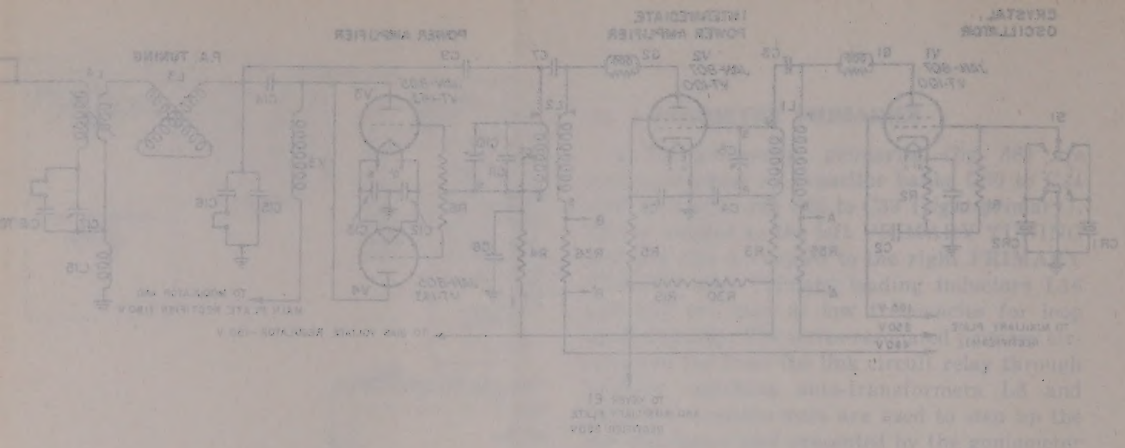
- S1 Crystal selector
- S7 Link tuning

TRANSFORMERS

- L12 Link circuit current (pri. 5 microhenries; sec. 13 millihenries)
- L13 Left antenna current (pri. 5 microhenries; sec. 13 millihenries)
- L14 Right antenna current (pri. 5 microhenries; sec. 13 millihenries)

TUBES

- V1 Crystal oscillator
- V2 Intermediate power amplifier
- V3 Power amplifier
- V4 Power amplifier



FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C17	Link circuit tuning (1,020 mmfd, variable)
C18	Link circuit tuning (500 mmfd, 5,000 rms test)
C19, C20	Link circuit tuning (0.001 mmfd, 5,000 rms test)

COILS

L3	P-a plate variometer (90-290 microhenries)
L4	Link circuit coupling variometer (pri. 23.5 microhenries; sec. 185 microhenries)
L8	Left goniometer primary matching auto-transformer (420 microhenries)
L9	Left goniometer primary matching auto-transformer (420 microhenries)
L15	Link circuit fixed coupler (30 microhenries)

RELAY

E2	Link circuit

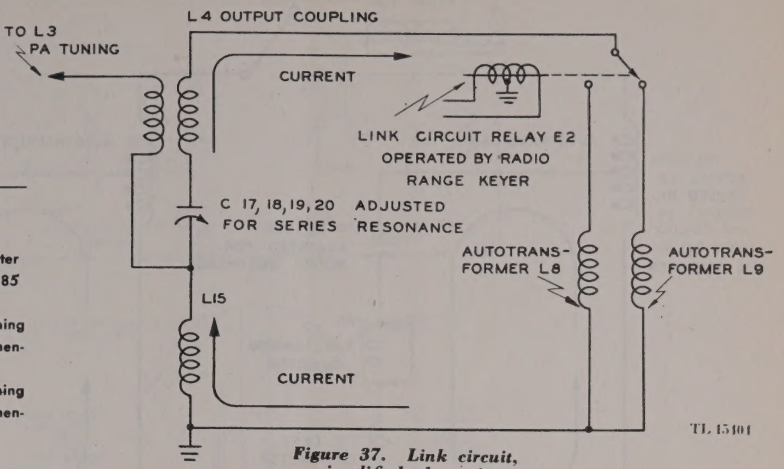


Figure 37. Link circuit, simplified schematic diagram.

DARY TUNING dial) and C51 (right SECONDARY TUNING dial) have both rotors and stators in two insulated sections. Secondary loading inductors L10 and L11 are shorted out when feeding loops. In single-ended arrangement, feeding transmission lines (fig. 39), one side is grounded, both capacitor banks are paralleled and connected in series with ungrounded side and loading inductors L10 and L11. Loading inductors permit resonating low inductance goniometer secondary at lower frequencies, since transmission lines are resistive (loops have relatively high inductance). If additional fixed capacitors were used to resonate goniometer secondary inductance alone, variable capacitor would contain too small a percentage of total capacitance and number of tuning bands at low frequencies would be excessive.

b. Secondary current is metered by current transformers L13 and L14, feeding rectifiers V19 and V20. Connection is same for either loops or transmission lines.

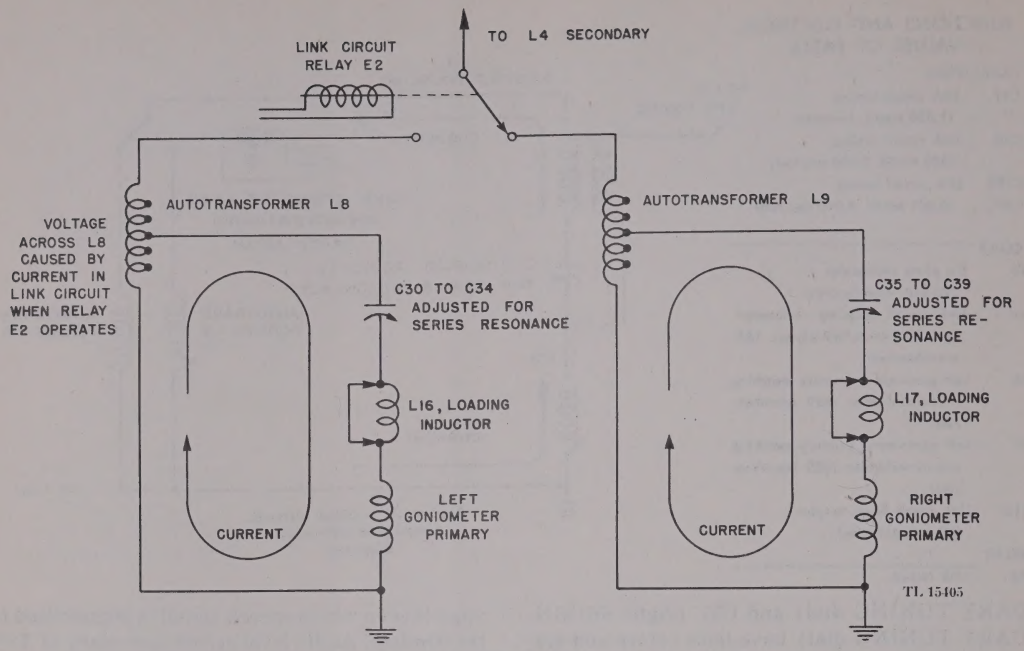
30. VOICE CIRCUITS

a. Voice signals originate in Remote Control Unit RM-45-A (fig. 41). D-c for microphone is supplied by rectifier on remote control unit from a voltage divider consisting of R1R in series and R4R in shunt. Capacitor C2R furnishes additional filtering for microphone current. R2R is MODULATION LEVEL control on remote control unit and functions by shunting microphone winding of T2R. Secondary of T2R matches the 600 ohm voice line on which speech signal is transmitted to transmitter. Audio level across secondary of T2R is metered by M1R. C3R is a d-c blocking capacitor and R3R is a meter multiplier. Calibration of M1R is such that, with 1.67 volts across 600 ohm line, it reads 100 percent modulation.

b. If transmitter gain is set so this level actually produces 100 percent modulation, M1R serves as a direct indicator of percent modulation. The 600 ohm telephone line connects between terminals 1 and 2 on remote control unit and 1 and 2 on transmitter (fig. 42). In transmitter it is connected to 600 ohm primary of voice input transformer T12. Secondary of T12 is loaded by dual potentiometer R29, the VOICE GAIN control. Output of R29 is connected to grids of audio amplifiers V7 and V8 by tone-voice switchover relay E10, when energized.

31. TONE OSCILLATOR

a. The audio tone used for range signal modulation is generated by V9, a JAN-807 beam tetrode, connected in a cathode tap Hartley circuit (fig. 42). Audio tank circuit consists of L6 in parallel with C66 for 1,020 cps output. To obtain 500 cps, C67 in parallel with C68 is connected by TONE FREQ. switch S6. Cathode bias is supplied by R25 bypassed by C26. Feedback for oscillation is obtained by returning cathode circuit to a tap on L6. Series grid resistor R24 is not bypassed and is intended to limit amplitude of oscillation, thus improving waveform. Screen volt-



FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C30	Left goniometer primary tuning (1,020 mmfd, variable)
C31	Left goniometer primary tuning (500 mmfd, 5,000 rms test)
C32	Left goniometer primary tuning (0.001 mfd, 5,000 rms test)
C33, C34	Left goniometer primary tuning (0.002 mfd, 6,000 rms test)
C35	Right goniometer primary tuning (1,020 mmfd, variable)
C36	Right goniometer primary tuning (500 mmfd, 5,000 rms test)

CAPACITORS (cont'd)

C37	Right goniometer primary tuning (0.001 mfd, 5,000 rms test)
C38, C39	Right goniometer primary tuning (0.002 mfd, 6,000 rms test)

COILS

L4	Link circuit coupling variometer (pri. 23.5 microhenries; sec. 185 microhenries)
L8	Left goniometer primary matching auto-transformer (420 microhenries)

COILS (cont'd)

L9	Right goniometer primary matching auto-transformer (420 microhenries)
L16	Left goniometer primary loading (14 microhenries)
L17	Right goniometer primary loading (14 microhenries)

RELAY

E2	Link circuit

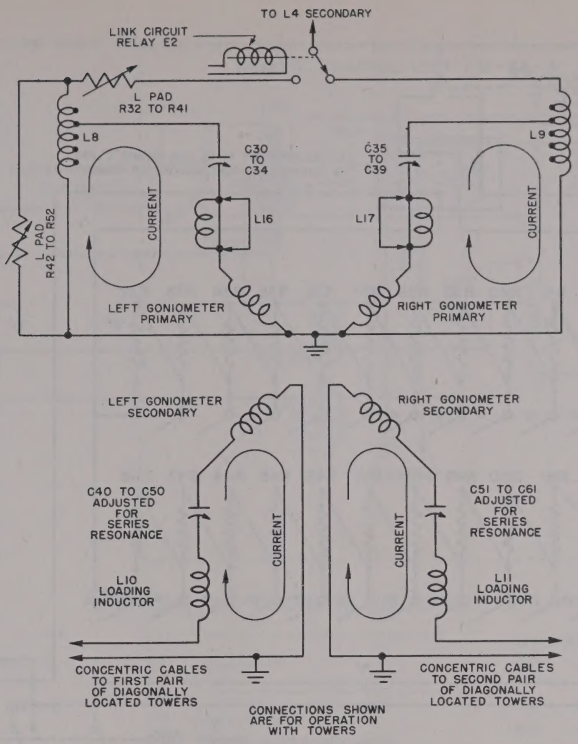
Figure 38. Goniometer primary, simplified schematic diagram.

age of approximately 125 volts is obtained from the auxiliary plate rectifier voltage divider and a second voltage divider composed of R26 and R27.

b. The audio oscillator is keyed by removing this positive voltage and applying a negative blocking bias. (This is accomplished simultaneously with the keying of the i-p-a stage.) The plate is supplied with approximately 420 volts from the auxiliary plate rectifier through dropping resistor R54 and parasitic suppressor G5. Audio output from the oscillator is taken from the cathode tap to ground through tone coupling transformer T7. The secondary of T7 is loaded by dual potentiometer R31, the TONE GAIN control, in shunt with harmonic filtering capacitor C69. The output of R31 is normally connected to the grids of the audio amplifier tubes, V7 and V8, by E10 in its normal unenergized position.

32. AUDIO AMPLIFIER

a. The audio amplifier consists of V7 and V8, JAN-807 beam tetrodes, connected as push-pull class A amplifiers. Cathode bias is supplied by R17. Screen voltage of approximately 250 volts is obtained from the auxiliary plate rectifier voltage divider. Plate voltage of approximately 500 volts is obtained from the auxiliary plate rectifier. The plates are coupled to the modulator grids by driver transformer T8. Parasitic suppressors G3 and G4 are connected in the plate leads.



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FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C30	Left goniometer primary tuning (1,020 mmfd, variable)
C31	Left goniometer primary tuning (500 mmfd, 5,000 rms test)
C32	Left goniometer primary tuning (0.001 mfd, 5,000 rms test)
C33, C34	Left goniometer primary tuning (0.002 mfd, 6,000 rms test)
C35	Right goniometer primary tuning (1,020 mmfd, variable)
C36	Right goniometer primary tuning (500 mmfd, 5,000 rms test)
C37	Right goniometer primary tuning (0.001 mfd, 5,000 rms test)
C38, C39	Right goniometer primary tuning (0.002 mfd, 6,000 rms test)
C40	Left goniometer secondary tuning (40-540 mmfd, dual, variable)
C41, C42	Left goniometer secondary tuning (0.001 mfd, 8,000 rms test)
C43, C44	Left goniometer secondary tuning (500 mmfd, 8,000 rms test)
C45	Left goniometer secondary tuning (250 mmfd, 8,000 rms test)
C46, C47	Left goniometer secondary tuning (0.001 mfd, 8,000 rms test)

CAPACITORS (cont'd)

C48, C49	Left goniometer secondary tuning (500 mmfd, 8,000 rms test)
C50	Left goniometer secondary tuning (250 mmfd, 8,000 rms test)
C51	Right goniometer secondary tuning (40-540 mmfd, dual, variable)
C52, C53	Right goniometer secondary tuning (0.001 mfd, 8,000 rms test)
C54, C55	Right goniometer secondary tuning (500 mmfd, 8,000 rms test)
C56	Right goniometer secondary tuning (250 mmfd, 8,000 rms test)
C57, C58	Right goniometer secondary tuning (0.001 mfd, 8,000 rms test)
C59, C60	Right goniometer secondary tuning (500 mmfd, 8,000 rms test)
C61	Right goniometer secondary tuning (250 mmfd, 8,000 rms test)

COILS

L4	Link circuit coupling variometer (pri. 23.5 microhenries; sec. 185 microhenries)

COILS (cont'd)

L8	Left goniometer primary matching auto-transformer (420 microhenries)
L9	Right goniometer primary matching auto-transformer (420 microhenries)
L10	Left goniometer secondary loading (65 microhenries)
L11	Right goniometer secondary loading (65 microhenries)
L16	Left goniometer primary loading (14 microhenries)
L17	Right goniometer primary loading (14 microhenries)

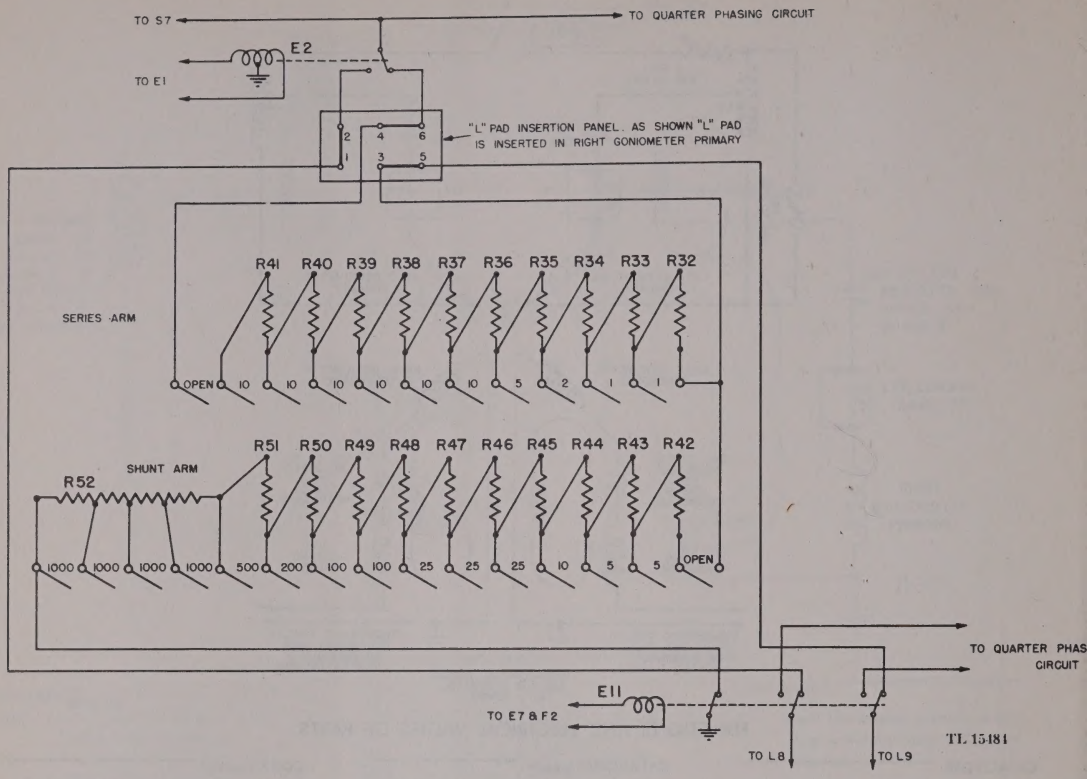
RELAY

E2	Link circuit

RESISTORS

R32	L pad series arm (1 ohm, 40 w)
R33	L pad series arm (1 ohm, 40 w)
R34	L pad series arm (2 ohms, 40 w)
R35	L pad series arm (5 ohms, 40 w)
R36 thru R41	L pad series arm (10 ohms, 40 w)

Figure 39. Goniometer, simplified schematic diagram showing L pad and tower connections


TO S7
TO QUARTER PHASING CIRCUIT
E2
TO E1
"L" PAD INSERTION PANEL. AS SHOWN "L" PAD IS INSERTED IN RIGHT GONIOMETER PRIMARY
2 4 6
1 3 5
SERIES ARM
R41 R40 R39 R38 R37 R36 R35 R34 R33 R32
OPEN 10 10 10 10 10 10 5 2 1 1
SHUNT ARM
R52
R51 R50 R49 R48 R47 R46 R45 R44 R43 R42
1000 1000 1000 1000 500 200 100 100 25 25 25 10 5 5 OPEN
TO QUARTER PHAS
CIRCUIT
E11
TO E7 & F2
TO L8
TO L9
TL 15181

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

COILS

L8	Left goniometer primary matching auto-transformer (420 microhenries)
L9	Right goniometer primary matching auto-transformer (420 microhenries)

FUSE

F2	Control circuit (3 amp)

RELAYS

E1	A-N and identification signal keyer
E2	Link circuit
E7	Remote control voice-range switch-over
E11	Quarter-phasing

RESISTORS

R32	L pad series arm (1 ohm, 40 w)
R33	L pad series arm (1 ohm, 40 w)
R34	L pad series arm (2 ohms, 40 w)
R35	L pad series arm (5 ohms, 40 w)
R36 thru R41	L pad series arm (10 ohms, 40 w)
R42	L pad shunt arm (5 ohms, 40 w)
R43	L pad shunt arm (5 ohms, 40 w)
R44	L pad shunt arm (10 ohms, 40 w)
R45	L pad shunt arm (25 ohms, 40 w)
R46	L pad shunt arm (25 ohms, 40 w)
R47	L pad shunt arm (25 ohms, 40 w)
R48	L pad shunt arm (100 ohms, 40 w)
R49	L pad shunt arm (100 ohms, 40 w)
R50	L pad shunt arm (200 ohms, 40 w)
R51	L pad shunt arm (500 ohms, 40 w)
R52	L pad shunt arm (4,000 ohms, 40 w)

SWITCH

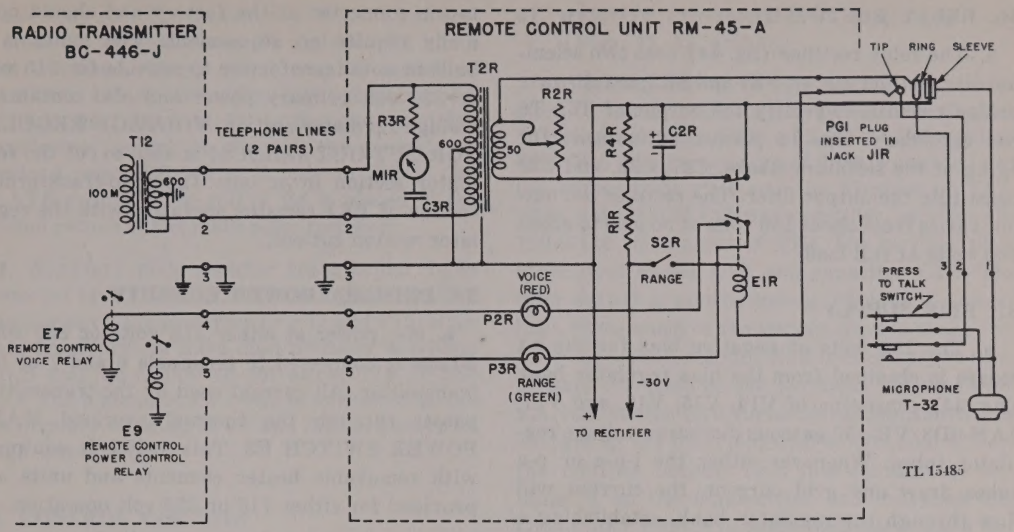
S7	Link tuning

Figure 40. Course shifting L pad, schematic diagram.

33. MODULATOR

a. The modulator consists of V5 and V6, JAN-805 triodes, in a push-pull zero bias class B circuit. The grids are driven by the audio amplifier through the driver transformer T8, R66 serving to improve driver regulation. The plates are fed with approximately 1,200 volts d-c from the main plate rectifier. The modulator output is coupled to the r-f, p-a plate circuit by modulation transformer T9.

b. The actual modulation voltage is metered by A.C. METER M2, when the A-C METER SWITCH S9 is in MOD. position, C70 serving to block off d-c voltage and R7 and R8 acting as multipliers (fig. 35). R8 is connected to ground



FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS
- C2R Microphone filter (200 mfd, 50 v d-c working)
- C3R Meter blocking (4 mfd, 100 v d-c working)

JACK
- J1R Microphone

METER
- M1R Audio line level

PILOTS
- P2R Voice (35 v)
- P3R Range (35 v)

PLUG
- PG1 Microphone

RELAYS
- E1R Press-to-talk
- E7 Remote control voice-range switch-over
- E9 Remote power control

RESISTORS
- R1R Microphone dropping (250 ohms, 25 w)

RESISTORS (cont'd)
- R2R Microphone level control rheostat (5-500 ohms)
- R3R Meter multiplier (2,500 ohms, 2 w)
- R4R Microphone bleeder (250 ohms, 25 w)

SWITCH
- S2R Range on-off

TRANSFORMERS
- T2R Microphone to line
- T12 Voice input

Figure 41. Control and audio circuits, functional diagram.

when the A.C. METER SWITCH is in FIL. position so that R7 and R8 are always in the circuit serving as bleeder resistors to protect the modulation transformer from the high voltages which would appear should the r-f, p-a load be lost. Modulator cathode current is metered by measuring the voltage drop across R58 which is located in the filament winding center tap return.

34. MAIN PLATE RECTIFIER

a. The main plate rectifier (fig. 43) uses V12 and V13, JAN-872A mercury vapor rectifier tubes in a full-wave circuit, rectifying the output of T1. The rectifier output is filtered by a single choke input section consisting of X4, C24, and C25. The d-c output is approximately 1,200 volts under load.

b. R11, R12, and R13 in series with R59 constitute both a bleeder and voltmeter multiplier, the rectifier voltage being metered by measuring the drop across R59. The rectifier is protected against overload by relay E8. The coil of E8 is connected in the T1 center tap return and the contacts are in series with the plate transformer primary power. The handle of E8 is used as the PLATE switch.

35. AUXILIARY PLATE RECTIFIER

a. The auxiliary plate rectifier (fig. 43) uses V10 and V11, JAN-866A/866 mercury vapor rectifiers in a full-wave circuit, rectifying the output of T4.

b. The rectifier output is filtered by a single choke input section, consisting of X5 and C22 and C23. R14, R15, and R16 are used as the voltage divider. The full rectifier output voltage is approximately 540 volts under load.

36. RELAY RECTIFIER

a. The relay rectifier (fig. 44) uses two selenium disc rectifier stacks, SR1 and SR2, in full-wave bridge circuits, to rectify the output of T6. T6 has secondary taps to permit adjustment for aging of the selenium stacks. C27, C28, and C29 constitute the output filter. The rectifier d-c output varies from about 150 volts at no load to about 100 volts at full load.

37. BIAS SUPPLY

a. The 150 volts of negative bias for the r-f stages is obtained from the bias regulator bank (fig. 44) consisting of V14, V15, V16, and V17, JAN-0D3/VR-150 gaseous discharge voltage regulator tubes. Whenever either the i-p-a or p-a tubes draw any grid current, the current will flow through the regulator bank, establishing a fixed 150 volt drop across the bank. Should excitation fail, the 100 to 130 volt output of the relay rectifier will appear across the bank through isolating resistor R18, protecting the i-p-a and p-a tubes from excessive plate current. Resistors R20 to R23, connected in series with the voltage regulator tubes, serve to equalize small differences in regulator tube characteristics.

38. FILAMENT CIRCUITS

a. All vacuum tube filaments (fig. 45) and heaters are energized by transformers as follows:

(1) Tubes V1, V2, V7, V8, V9, V18, V19, and V20 from the 6.3 volt secondary of T5
(2) Tubes V3 and V4 from the first 10 volt secondary of T5
(3) Tubes V5 and V6 from the second 10 volt secondary of T5
(4) Tubes V10 and V11 from the 2.5 volt secondary of T3
(5) Tubes V12 and V13 from the 5 volt secondary of T2

b. The primaries of all the filament transformers are fed by filament voltage stabilizer VR1. This device holds substantially constant output voltage for input voltages varying plus or minus 15% from the nominal values of 115 and 230, and frequency varying from 57 to 63 cps. VR1 is provided with three taps giving nominal outputs of 114 v, 115 v, and 116 v. The optimum tap is connected at the factory and should normally require no adjustment. VR1 contains a built-in auto-transformer to provide for 115 volt or 230 volt primary power and also contains a voltage regulator section. VOLTAGE REGULATOR CUT-OUT switch S4 is used to cut the regulator section in or out. The auto-transformer section of VR1 remains operative with the regulator section cut-out.

39. PRIMARY POWER CIRCUITS

a. A-c power at either 115 volts or 230 volts 60 cps is connected to terminals 6 and 7 of the transmitter. All current used by the transmitter passes through the thermal overload MAIN POWER SWITCH E3. This switch is equipped with removable heater elements and units are provided for either 115 or 230 volt operation.

b. Connected directly across the output of E3 are the mercury vapor tube heaters, H1, H2, H3, and H4, in series with thermostat TH1. The tube heater connections are grouped so that they can be operated in series-parallel on 230 volts and in parallel on 115 volts. TH1 serves to turn on the heaters at tube temperatures below 60 F, and to turn them off at tube temperatures above 70 F.

c. Also connected directly across the E3 output is the relay auto-transformer T10. This transformer is necessary for 230 volt operation, since all relays have 115-volt coils. Fuses F1 and F2 protect the relay circuits. In addition to the relays, the auto-transformer feeds crystal heater H5. This heater keeps the crystals slightly above ambient temperature to prevent moisture condensation. The output of E3 is connected to the blower B1, and the primary circuits of the filament voltage regulator and relay rectifier by filament contactor E4 (fig. 18).

d. The blower B1 (fig. 46) is protected by fuses F14 and F15, and is turned on by thermostat TH2, when the temperature exceeds 70° F, and off at temperatures below 60° F. The blower has a dual winding to provide for 115 to 230 volt operation. The filament voltage stabilizer VR1 is protected by fuses F7 and F8.

e. Filament pilot P1 (green) is connected across the voltage regulator output. The primary

of the relay rectifier transformer T6 is fed directly from E4 through fuses F3 and F4. T6 has a dual winding primary which may be connected for either 115 or 230 volts. Plate contactor E6 connects the output of E3 to the plate rectifier transformer primaries through the contacts of overload relay E8. (The handle of E8 is the PLATE switch.) The coil of E8 is placed in the ground return of the main plate rectifier.

f. Auxiliary plate rectifier transformer T4 is protected by F5 and F6, and main plate rectifier transformer T1 is protected by F11 and F12. Both plate transformers have dual primary windings which may be connected for either 115 or 230 volts. The plate pilot P2 (red) is connected across one primary winding of T1 and thus is always on a 115 volt circuit.

40. CONTROL CIRCUITS

a. In normal operation, LOCAL-REMOTE switch S2 (fig. 35) is in REMOTE position. If E9 is energized by direct current from the remote control unit entering through terminal 5, alternating current from T10 will be applied to the coil of E4 through over-temperature thermostat TH4. TH4 shuts down the equipment should the temperature exceed 160 F. When E4 is energized, thereby putting power into the filament primary circuits, time delay relay E5 is energized. After a 30 second time delay, the contact on E5 will close, energizing plate contactor E6 from the relay auto-transformer T10 through door switches S10 and S11 and under-temperature thermostat TH3. TH3 serves to delay application of plate power, until the mercury vapor rectifiers have been heated to at least 60 F. With the LOCAL-REMOTE switch in LOCAL position, E4 cannot be energized by E9, but can be energized by the FILAMENT switch S3. In either LOCAL or REMOTE positions, the PLATE switch (handle of overload relay E8) must be in ON position to complete the actual primary circuit to the plate rectifiers.

b. With E10 and E11 in their normal unenergized positions, the transmitter functions to produce a radio range signal. When E7 is energized by direct current entering terminal 4 from the remote control unit, the contact on E7 supplies power from T10 to the coils of E10 and E11, energizing them and placing the transmitter in voice broadcast condition.

41. REMOTE CONTROL UNIT CIRCUITS (Figs. 41, 47, and 48)

a. Primary power of 115 volt, 60 cps, is applied to the primary of the power transformer T1R through fuse F1R and A.C. LINE switch S1R. The 5 volt secondary of T1R is used to light the amber pilot P1R and the filament of V1R. V1R, a JAN-5Z3 full-wave rectifier, rectifies the 110-0-110 volt output of T1R. The rectifier filter consists of choke X1R and capacitor C1R. The filter output is approximately 30 volts d-c under load. Since much of the voltage drop is in the rectifier tube itself, resistor R5R is necessary to compensate for some of the variation among tubes. RANGE switch S2R turns on the transmitter by energizing the line connected to terminal 5 from the rectifier output. This line connects to terminal 5 on the transmitter and energizes E9. Green pilot P3R is in series with terminal 5 and lights when the circuit is energized. Most of the circuit voltage drop occurs across P3R, swamping the effect of the telephone line resistance. The return circuit for the control current is through the voice lines 1 and 2 which are phantomed by grounding the center tap on the line windings of T2R and T12.

b. When the microphone is plugged into the MICROPHONE JACK J1R, the plug sleeve terminal is grounded. If the PRESS TO TALK tab is depressed, E1R is energized by grounding its coil through the microphone plug tip circuit. This removes the back-contact short across the microphone filter capacitor C2R and energizes terminal 4 through the red pilot P2R. The PRESS TO TALK tab also connects the other microphone terminal through the microphone plug ring circuit to the primary of T2R. The other side of the T2R primary connects to the microphone supply voltage available across C2R.

c. R2R serves as MODULATION LEVEL control by shunting T2R. The output of T2R goes directly to the voice line, terminals 1 and 2. M1R in series with C3R and R3R meters the audio level. Terminal 4 connects to terminal 4 on the transmitter. When it is energized by E1R, relay E7 is energized, throwing the transmitter into voice operation. Pilot P3R has the same bulb type as P2R and operates similarly.

42. METERING CIRCUITS

a. D-C Meter Circuits.

(1) D.C. METER M1 (fig. 49) is a 1 ma, full-scale instrument, with 2,400 ohms internal resistance. This resistance, plus 100 ohms of resistance in the d-c meter fuse F13 makes it a 2.5 volt, full-scale voltmeter, 1,000 ohms per volt. Direct currents and voltages are measured at various points in the the transmitter as follows:

Current or Voltage Measured	How Measured	Full Scale Reading of M1
Crystal oscillator plate current	Voltage drop across R55 (50 ohms)	50 ma
I-p-a plate current	Voltage drop across R56 (10 ohms)	250 ma
P-a cathode current	Voltage drop across R57 (5 ohms)	500 ma
Modulator cathode current	Voltage drop across R58 (5 ohms)	500 ma
Main plate rectifier voltage	Voltage drop across R59 (63 ohms) (R59 is in series with the 60,000 ohms bleeder)	2,500 v
Auxiliary plate rectifier voltage	R9 and R10 in series (total 1 megohm) used as voltmeter multipliers	1,000 v
Relay rectifier voltage	R28 (250,000 ohms) used as voltmeter multiplier	250 v

NOTE.—The various circuits are selected by D.C. METER SWITCH S8. Many of the metering resistors are mounted directly on S8. C65 serves to protect the meter and fuse from stray r-f currents.

(2) Radio-frequency currents in the link circuit and goniometer secondaries are measured by means of current transformers L12, L13, and L14, and rectifiers V18, V19, and V20, JAN-6H6G diodes. The current transformers are very high ratio step-up transformers, with load resistors across the high impedance secondaries. Screw adjusted, movable iron cores are used. (These cores are factory adjusted and should not be readjusted.) The secondary inductance and load resistor are so proportioned that over the frequency range 200 to 400 kc the secondary delivers a constant voltage for constant current in the primary. The rectifier tube outputs are bypassed and hence the tubes operate as peak rectifiers. The rectifier load resistors, R61 for the link current, and R63 and R65 for the secondary currents, are high enough in resistance to make variations among rectifier tubes negligible. (R61 is 35,000 ohms and R63 and R65 are 80,000 ohms each.) The individual current transformers are factory adjusted so that the link circuit metering rectifier deflects the D.C. METER to full scale for 2.5 amperes and the secondary metering rectifiers read full scale for 5.0 amperes. Since the rectifiers produce a direct-current output proportional to the average r-f current peaks, they show negligible change in reading when less than 100% linear modulation is applied to the carrier. (A slight drop, due to power supply regulation, is normal.) If the modulation exceeds 100%, the rectifier output will rise (carrier shift). This characteristic is useful in properly setting modulation level.

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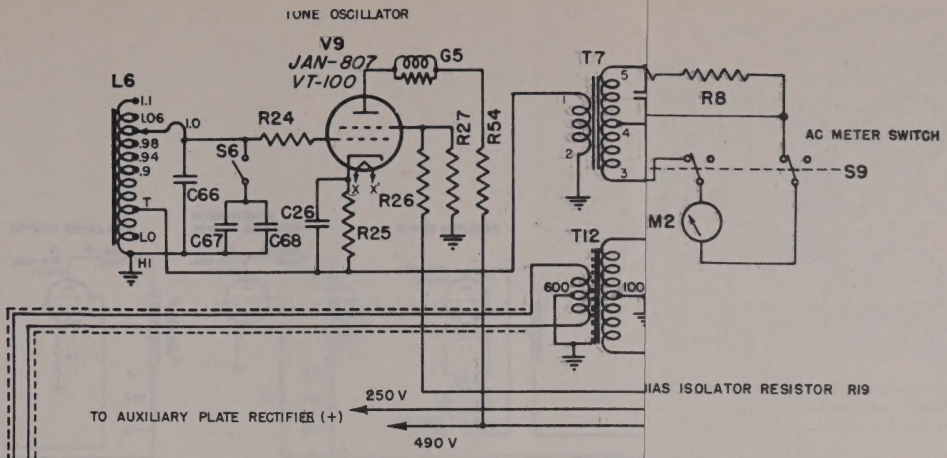

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FUNCTIONS AND ELECTRICA

CAPACITORS

C26	Audio oscillator cathode bypass (4 mfd, 600 v d-c working)
C66	Audio oscillator tuning (0.022 mfd, 300 v d-c working)
C67, C68	Audio oscillator tuning (0.0375 mfd, 300 v d-c working)
C69	Tone filter (0.05 mfd, 300 v d-c working)
C70	Modulation meter M2 blocking (0.1 mfd, 2,000 v d-c working)

COIL

L6	Tone oscillator tank (1 h)

METER

M2	A-c meter (0-150 v)

RELAYS

E1	A-N and identification signal keyer
E10	Tone-voice switch-over

RESISTORS

R7, R8	Modulation m ohms, 60 w)
R17	Audio amplifi ohms, 20 w)
R19	Bias isolator (
R24	Audio oscillat (100,000 ohr
R25	Audio oscillat (1,000 ohms,
R26, R27	Audio oscillat (25,000 ohm
R29	Voice gain co dual potenti
R31	Tone gain co dual potenti
R54	Audio oscillat (5,000 ohms,
R66	Modulator gri ohms, 20 w)
R67	Driver grid (1
R68	Driver grid (1

rcuits, functional diagram.

42. METERING CIRCUITS

a. D-C Meter Circuits.

(1) D.C. METER M1 (fig. 49) is a 1 ma, full-scale instrument, with 2,400 ohms internal resistance. This resistance, plus 100 ohms of resistance in the d-c meter fuse F13 makes it a 2.5 volt, full-scale voltmeter, 1,000 ohms per volt. Direct currents and voltages are measured at various points in the the transmitter as follows:

Current or Voltage Measured	How Measured	Full Scale Reading of M1
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P-a cathode current	Voltage drop across R57 (5 ohms)	500 ma
Modulator cathode current	Voltage drop across R58 (5 ohms)	500 ma
Main plate rectifier voltage	Voltage drop across R59 (63 ohms) (R59 is in series with the 60,000 ohms bleeder)	2,500 v
Auxiliary plate rectifier voltage	R9 and R10 in series (total 1 megohm) used as voltmeter multipliers	1,000 v
Relay rectifier voltage	R28 (250,000 ohms) used as voltmeter multiplier	250 v

NOTE.—The various circuits are selected by D.C. METER SWITCH S8. Many of the metering resistors are mounted directly on S8. C65 serves to protect the meter and fuse from stray r-f currents.

(2) Radio-frequency currents in the link circuit and goniometer secondaries are measured by means of current transformers L12, L13, and L14, and rectifiers V18, V19, and V20, JAN-6H6G diodes. The current transformers are very high ratio step-up transformers, with load resistors across the high impedance secondaries. Screw adjusted, movable iron cores are used. (These cores are factory adjusted and should not be readjusted.) The secondary inductance and load resistor are so proportioned that over the frequency range 200 to 400 kc the secondary delivers a constant voltage for constant current in the primary. The rectifier tube outputs are bypassed and hence the tubes operate as peak rectifiers. The rectifier load resistors, R61 for the link current, and R63 and R65 for the secondary currents, are high enough in resistance to make variations among rectifier tubes negligible. (R61 is 35,000 ohms and R63 and R65 are 80,000 ohms each.) The individual current transformers are factory adjusted so that the link circuit metering rectifier deflects the D.C. METER to full scale for 2.5 amperes and the secondary metering rectifiers read full scale for 5.0 amperes. Since the rectifiers produce a direct-current output proportional to the average r-f current peaks, they show negligible change in reading when less than 100% linear modulation is applied to the carrier. (A slight drop, due to power supply regulation, is normal.) If the modulation exceeds 100%, the rectifier output will rise (carrier shift). This characteristic is useful in properly setting modulation level.

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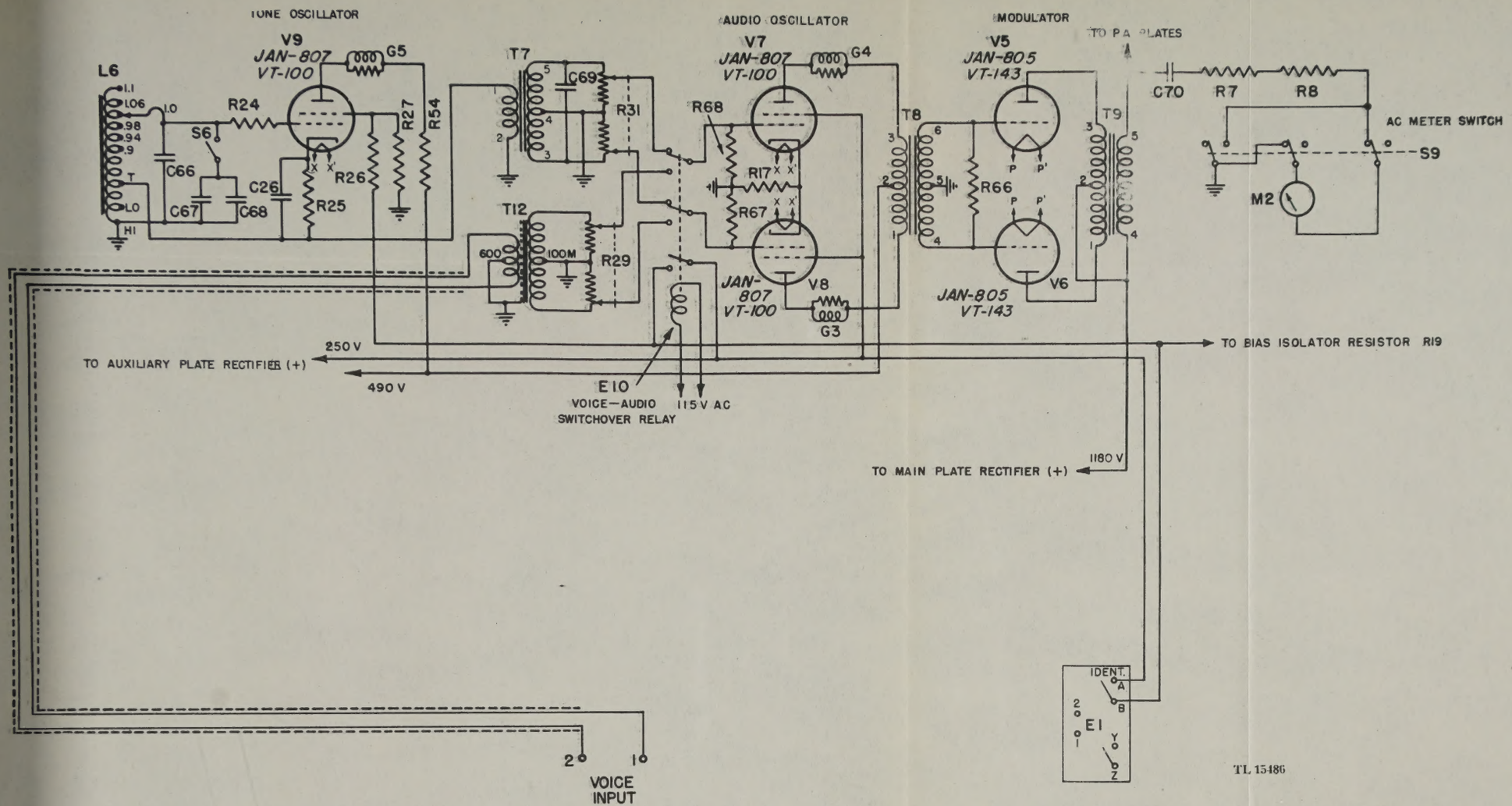


FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

- C26 Audio oscillator cathode bypass (4 mfd, 600 v d-c working)
- C66 Audio oscillator tuning (0.022 mfd, 300 v d-c working)
- C67, C68 Audio oscillator tuning (0.0375 mfd, 300 v d-c working)
- C69 Tone filter (0.05 mfd, 300 v d-c working)
- C70 Modulation meter M2 blocking (0.1 mfd, 2,000 v d-c working)

COIL

- L6 Tone oscillator tank (1 h)

METER

- M2 A-c meter (0-150 v)

RELAYS

- E1 A-N and identification signal keyer
- E10 Tone-voice switch-over

RESISTORS

- R7, R8 Modulation metering (50,000 ohms, 60 w)
- R17 Audio amplifier cathode bias (200 ohms, 20 w)
- R19 Bias isolator (50,000 ohms, 2 w)
- R24 Audio oscillator grid limiter (100,000 ohms, 2 w)
- R25 Audio oscillator cathode bias (1,000 ohms, 2 w)
- R26, R27 Audio oscillator screen bleeder (25,000 ohms, 2 w)
- R29 Voice gain control (50,000 ohms, dual potentiometer)
- R31 Tone gain control (3,000 ohms, dual potentiometer)
- R54 Audio oscillator plate dropping (5,000 ohms, 20 w)
- R66 Modulator grid loading (5,000 ohms, 20 w)
- R67 Driver grid (1 megohm, 2 w)
- R68 Driver grid (1 megohm, 2 w)

SUPPRESSORS

- G3 Audio driver V8 plate
- G4 Audio driver V7 plate
- G5 Tone oscillator plate

SWITCHES

- S6 Tone frequency
- S9 A-c meter

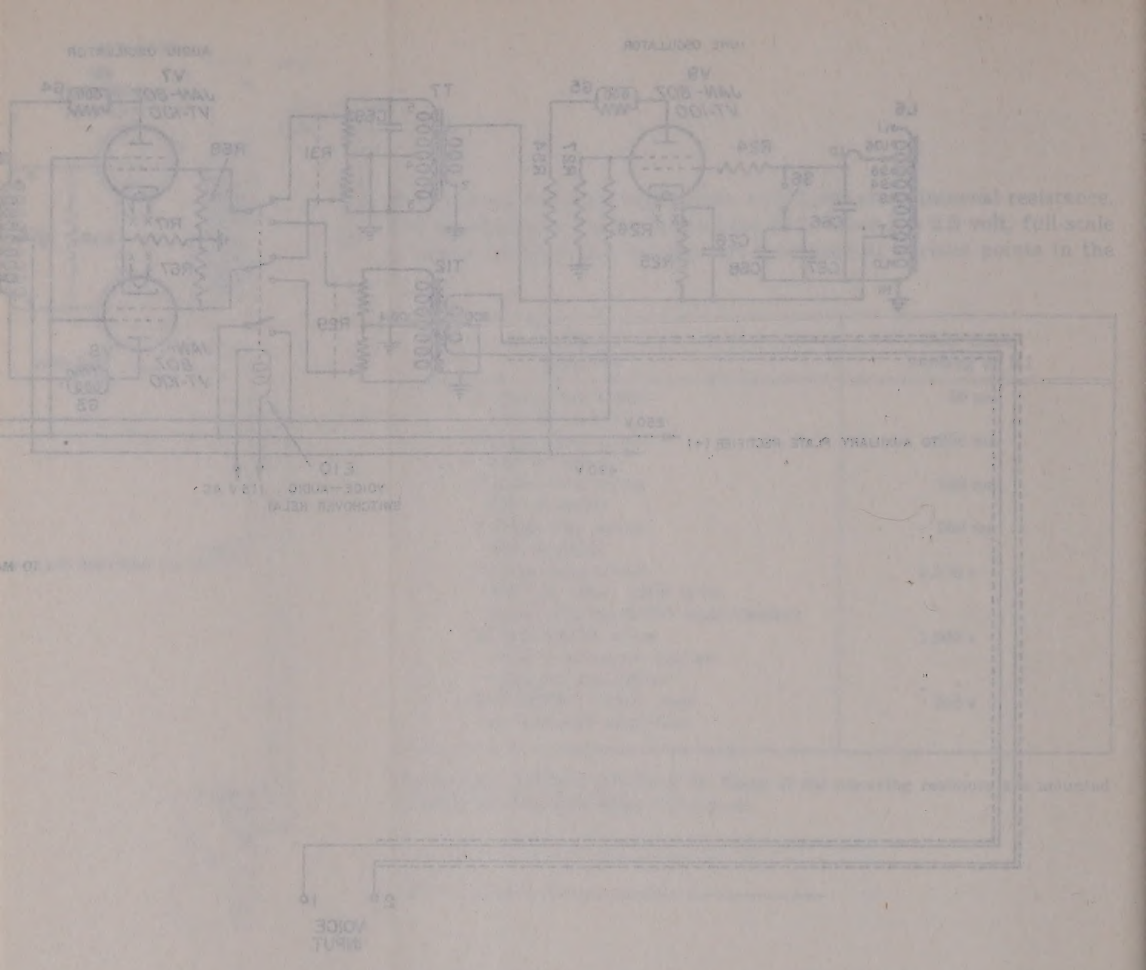
TRANSFORMERS

- T7 Tone input
- T8 Audio driver
- T9 Modulation
- T12 Voice input

TUBES

- V5 Modulator
- V6 Modulator
- V7 Audio amplifier
- V8 Audio amplifier
- V9 Audio oscillator

Figure 42. A-f circuits, functional diagram.



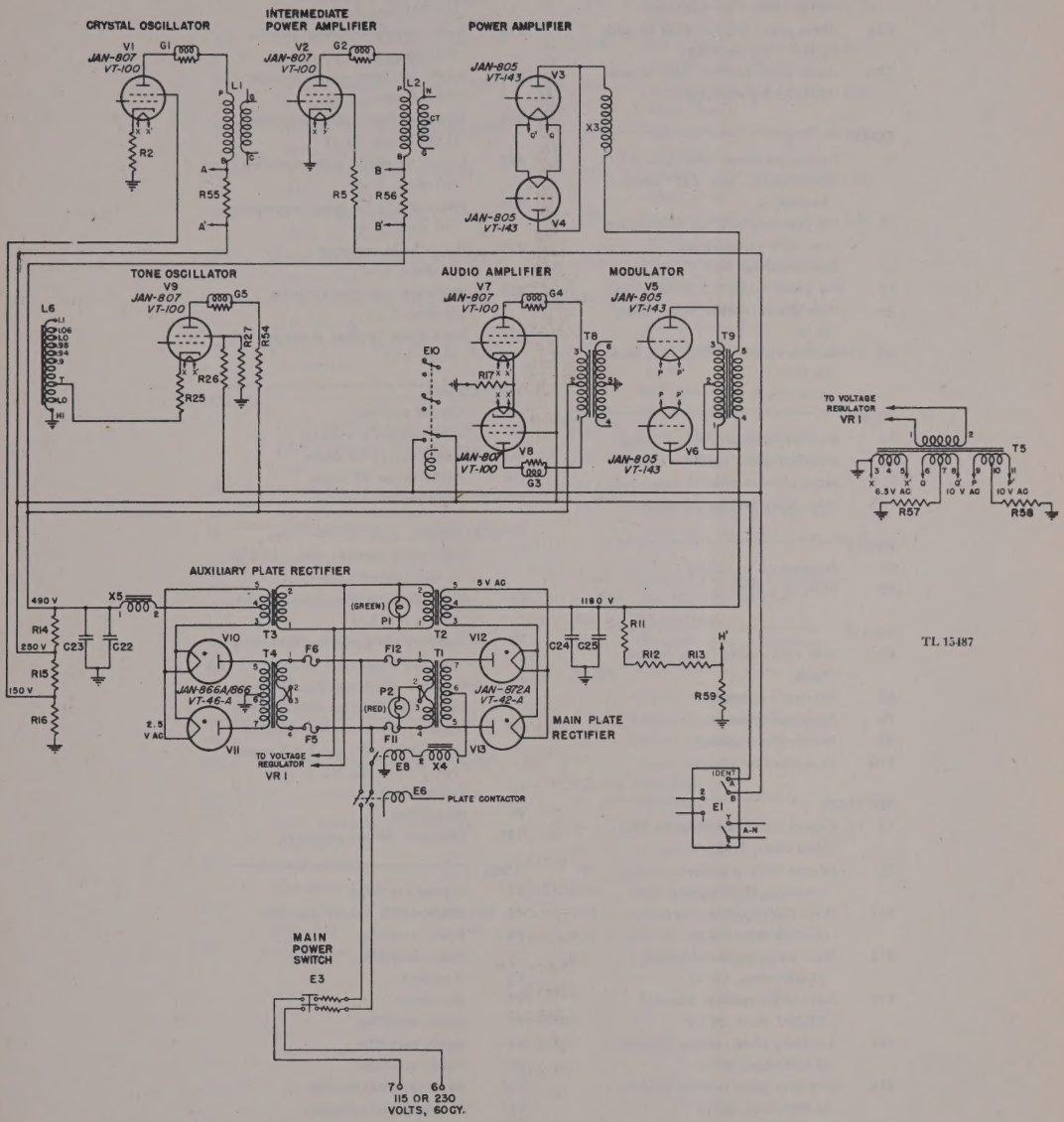


Figure 43. High voltage supply circuits, functional diagram.

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

- C22 Auxiliary plate rectifier filter (6 mfd, 1,000 v d-c working)
- C23 Auxiliary plate rectifier filter (6 mfd, 1,000 v d-c working)
- C24 Main plate rectifier filter (6 mfd, 2,000 v d-c working)
- C25 Main plate rectifier filter (6 mfd, 2,000 v d-c working)

COILS

- L1 Crystal oscillator tank (pri. 4.7 millihenries; sec. 725 microhenries)
- L2 P-a coupling (pri. 4.7 millihenries; sec. 620 microhenries)
- L6 Tone oscillator tank (1 h)
- X3 P-a plate choke (15 millihenries)
- X4 Main plate rectifier filter choke (6 h)
- X5 Auxiliary plate rectifier filter choke (8 h)

FUSES

- F5 Auxiliary plate rectifier (3 amp)
- F6 Auxiliary plate rectifier (3 amp)
- F11 Main plate rectifier (5 amp)
- F12 Main plate rectifier (5 amp)

PILOTS

- P1 Filament (6 w, 120 v)
- P2 Plate (6 w, 120 v)

RELAYS

- E1 A-N and identification signal keyer
- E3 Thermal overload
- E6 Plate contactor
- E8 Main plate overload
- E10 Tone-voice switch-over

RESISTORS

- R2 Crystal oscillator cathode bias (400 ohms, 2 w)
- R5 Intermediate p-a screen dropping (3,000 ohms, 2 w)
- R11 Main plate rectifier bleeder (20,000 ohms, 60 w)
- R12 Main plate rectifier bleeder 20,000 ohms, 60 w)
- R13 Main plate rectifier bleeder (20,000 ohms, 60 w)
- R14 Auxiliary plate rectifier bleeder (3,000 ohms, 60 w)
- R15 Auxiliary plate rectifier bleeder (2,000 ohms, 60 w)
- R16 Auxiliary plate rectifier bleeder (3,000 ohms, 60 w)

RESISTORS (cont'd)

- R17 Audio amplifier cathode bias (200 ohms, 20 w)
- R25 Audio oscillator cathode bias (1,000 ohms, 2 w)
- R26 Audio oscillator screen bleeder (25,000 ohms, 2 w)
- R27 Audio oscillator screen bleeder (25,000 ohms, 2 w)
- R54 Audio oscillator plate dropping (5,000 ohms, 20 w)
- R55 Crystal oscillator plate metering (50 ohms, 2 w)
- R56 Intermediate p-a plate metering (10 ohms, 2 w)
- R57 P-a cathode metering (5 ohms, 2 w)
- R58 Modulator cathode metering (5 ohms, 2 w)
- R59 Main plate rectifier metering (63 ohms, 2 w)

SUPPRESSORS

- G1 Crystal oscillator
- G2 Intermediate p-a plate
- G3 Audio driver V8 plate
- G4 Audio driver V7 plate
- G5 Tone oscillator plate

TRANSFORMERS

- T1 Main plate rectifier (pri. 115-230 v; sec. 1,500-0-1,500 v)
- T2 Main plate rectifier filament (pri. 115 v; sec. 5 v)
- T3 Auxiliary plate rectifier filament pri. 115 v; sec. 2.5 v)
- T4 Auxiliary plate rectifier filament (pri. 115-230 v; sec. 625-0-625 v)
- T5 Auxiliary plate rectifier filament (pri. 115 v; sec. No. 1 6.3 v; sec. No. 2 10 v; sec. No. 3 10 v)
- T8 Audio driver
- T9 Modulation
- VR1 Filament voltage regulator

TUBES

- V1 Crystal oscillator
- V2 Intermediate power amplifier
- V3 Power amplifier
- V4 Power amplifier
- V5 Modulator
- V6 Modulator
- V7 Audio amplifier
- V8 Audio amplifier
- V9 Audio oscillator
- V10 Auxiliary plate rectifier
- V11 Auxiliary plate rectifier
- V12 Main plate rectifier
- V13 Main plate rectifier

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C1	Crystal oscillator cathode bypass (0.01 mfd, 600 v d-c working)
C4	Intermediate p-a grid bypass (0.01 mfd, 600 v d-c working)
C5	Crystal oscillator tuning (40-1,050 mmfd, variable)
C8	P-a grid bypass (0.01 mfd, 600 v d-c working)
C10	Intermediate p-a tuning (40-1,050 mmfd, variable)
C12	P-a filament bypass (0.01 mfd, 600 v d-c working)
C13	P-a filament bypass (0.01 mfd, 600 v d-c working)
C27	Relay rectifier filter (4 mfd, 600 v d-c working)
C28	Relay rectifier filter (4 mfd, 600 v d-c working)
C29	Relay rectifier filter (4 mfd, 600 v d-c working)

COILS

L1	Crystal oscillator tank (pri. 4.7 millihenries; sec. 725 microhenries)
L2	P-a coupling (pri. 4.7 millihenries; sec. 620 microhenries)
L6	Tone oscillator tank (1 h)

FUSES

F3, F4	Relay rectifier (1 amp)

RELAYS

E3	Thermal overload
E4	Filament contactor

RECTIFIERS

SR1, SR2	Bias and relay (¼ amp, 120 v d-c)

RESISTORS

R1	Crystal oscillator grid bias (1 megohm, 2 w)
R2	Crystal oscillator cathode bias (400 ohms, 2 w)
R3	Intermediate p-a grid bias (25,000 ohms, 2 w)
R4	P-a grid bias (500 ohms, 60 w)

RESISTORS (cont'd)

R6	P-a grid suppressor (250 ohms, 40 w)
R17	Audio amplifier cathode bias (200 ohms, 20 w)
R18	Bias voltage regulator limiting (10,000 ohms, 2 w)
R20	Regulator tube V14 equalizer (500 ohms, 2 w)
R21	Regulator tube V15 equalizer (500 ohms, 2 w)
R22	Regulator tube V16 equalizer (500 ohms, 2 w)
R23	Regulator tube V17 equalizer (500 ohms, 2 w)
R24	Audio oscillator grid limiter (100,000 ohms, 2 w)
R25	Audio oscillator cathode bias (1,000 ohms, 2 w)
R57	P-a cathode metering (5 ohms, 2 w)
R58	Modulator cathode metering (5 ohms, 2 w)
R67	Driver grid (1 megohm, 2 w)
R68	Driver grid (1 megohm, 2 w)

TRANSFORMERS

T5	Filament (pri. 115 v; sec. No. 1 6.3 v; sec. No. 2 10 v; sec. No. 3 10 v)
T6	Relay rectifier (pri. 115-230 v; sec. 100-120-140 v)
T8	Audio driver
VR1	Filament voltage regulator

TUBES

V1	Crystal oscillator
V2	Intermediate power amplifier
V3	Power amplifier
V4	Power amplifier
V5	Modulator
V6	Modulator
V7	Audio amplifier
V8	Audio amplifier
V9	Audio oscillator
V14	Bias voltage regulator
V15	Bias voltage regulator
V16	Bias voltage regulator
V17	Bias voltage regulator

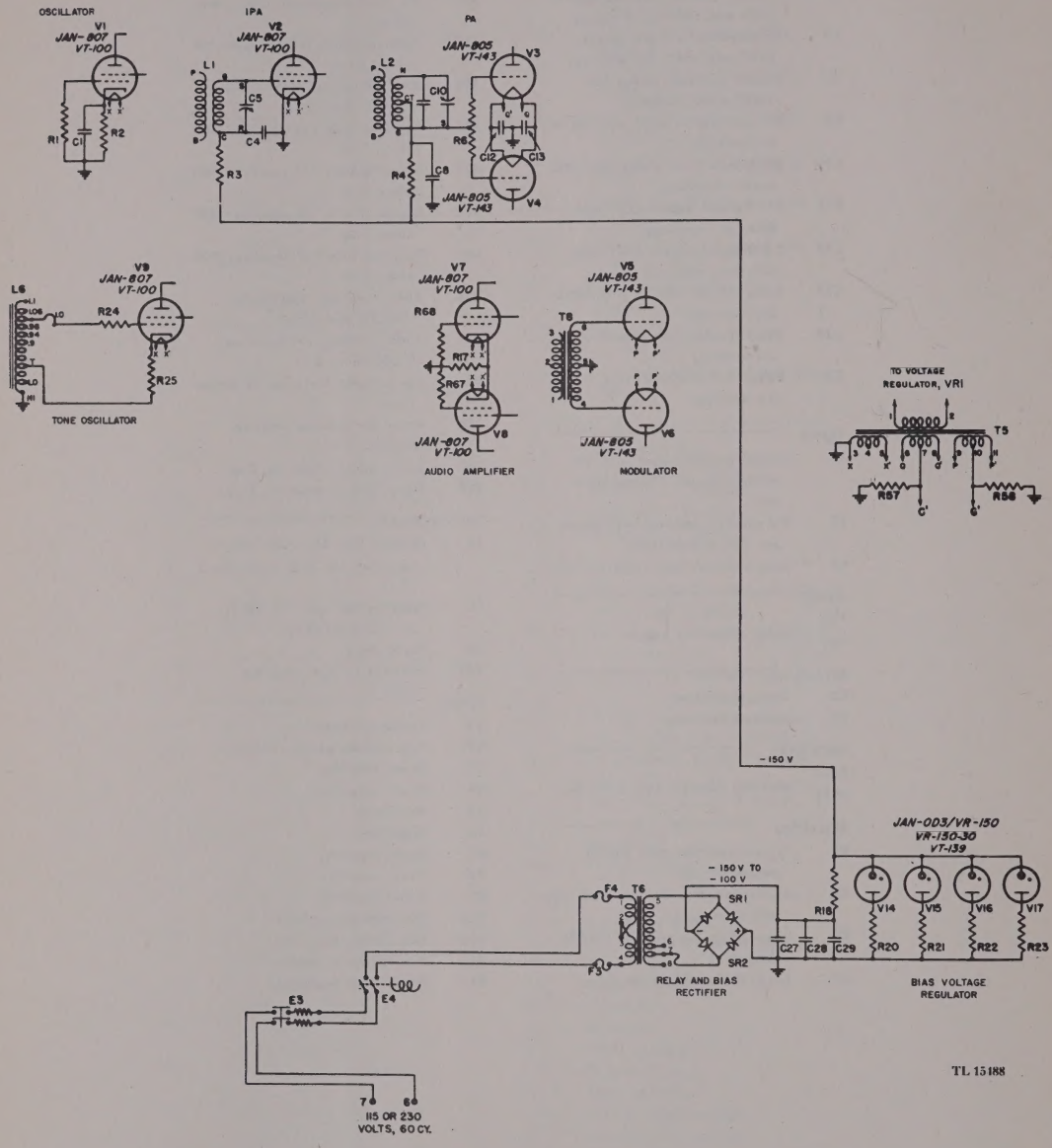


Figure 44. Bias supply circuits, functional diagram.

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

FUSES

F1	Control circuit (3 amp)
F2	Control circuit (3 amp)
F7	Filament supply (5 amp)
F8	Filament supply (5 amp)

HEATERS

H1	Tube V10 (100 w)
H2	Tube V11 (100 w)
H3	Tube V12 (100 w)
H4	Tube V13 (100 w)
H5	Crystal (2,000 ohms, 40 w)

PILOT

P1	Filament

RELAYS

E3	Thermal overload
E4	Filament contactor
E5	Time delay

RESISTORS

R57	Power amplifier cathode metering (5 ohms, 2 w)
R58	Modulator cathode metering (5 ohms, 2 w)

SWITCHES

S4	Voltage regulator cut-out
TH1	Tube heater thermostatic

TRANSFORMERS

T2	Main plate rectifier filament (pri. 115 v; sec. 5 v)
T3	Auxiliary plate rectifier filament (pri. 115 v; sec. 2.5 v)
T5	Filament (pri. 115 v; sec. No. 1 6.30; sec. No. 2 10 v; sec. No. 3 10 v)
T10	Relay auto transformer (230-115 v)
VR1	Filament voltage regulator

TUBES

V1	Crystal oscillator
V2	Intermediate power amplifier
V3	Power amplifier
V5	Modulator
V6	Modulator
V7	Audio amplifier
V8	Audio amplifier
V9	Audio oscillator
V10	Auxiliary plate rectifier
V11	Auxiliary plate rectifier
V12	Main plate rectifier
V13	Main plate rectifier
V18	Link circuit meter rectifier
V19	Left goniometer meter rectifier
V20	Right goniometer meter rectifier

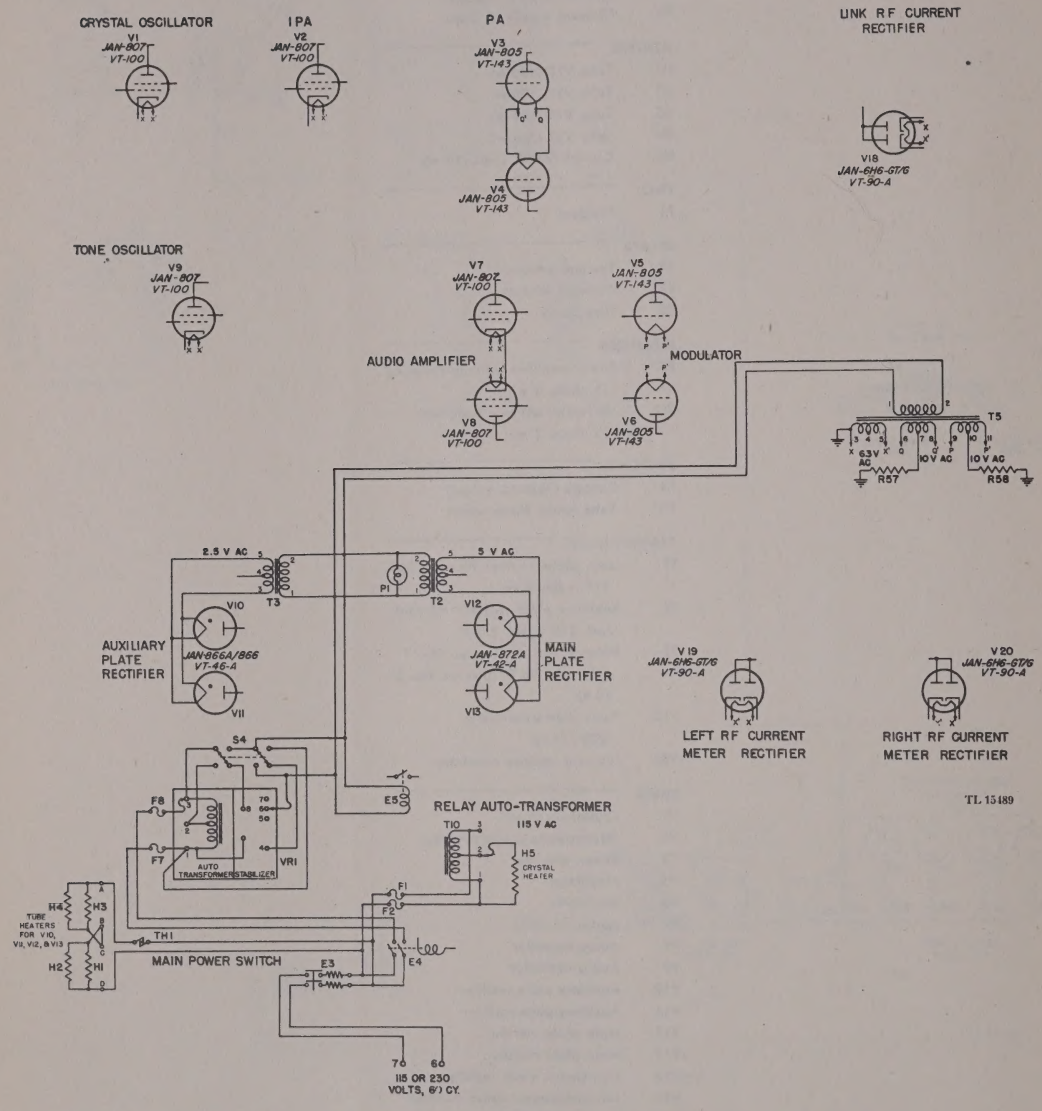


Figure 45. Filament and heater circuits, functional diagram.

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C4	Intermediate p-a grid bypass (0.01 mfd, 600 v d-c working)
C5	Crystal oscillator tuning (40-1,050 mmfd, variable)
C6	Intermediate p-a screen bypass (0.01 mfd, 600 v d-c working)
C26	Audio oscillator cathode bypass (4 mfd, 600 v d-c working)
C27, C28, C29	Relay rectifier filter (4 mfd, 600 v d-c working)
C62	Quarter-phasing (0.002 mfd, 1,200 v d-c working)
C63	Quarter-phasing (0.004 mfd, 1,200 v d-c working)
C64	Quarter-phasing (0.008 mfd, 1,200 v d-c working)
C66	Audio oscillator tuning (0.022 mfd, 300 v d-c working)
C67, C68	Audio oscillator tunng (0.0375 mfd, 300 v d-c working)
C69	Tone filter (0.05 mfd, 300 v d-c working)

COILS

L1	Crystal oscillator tank (pri. 4.7 millihenries; sec. 725 microhenries)
L6	Tone oscillator tank (1 h)
L7	Quarter-phasing (88 microhenries)
L8	Left goniometer primary matching auto-transformer (420 microhenries)
L9	Right goniometer primary matching auto-transformer (420 microhenries)
X4	Main plate rectifier filter choke (6 h)

FUSES

F1	Control circuit (3 amp)
F2	Control circuit (3 amp)
F3	Relay rectifier (1 amp)
F4	Relay rectifier (1 amp)
F5	Auxiliary plate rectifier (3 amp)
F6	Auxiliary plate rectifier (3 amp)
F7	Filament supply (5 amp)
F8	Filament supply (5 amp)
F9	Keyer motor (1 amp)
F10	Keyer motor (1 amp)
F11	Main plate rectifier (5 amp)
F12	Main plate rectifier (5 amp)
F14	Blower motor (3 amp)
F15	Blower motor (3 amp)

MOTOR

B1	Blower (1.55 amp 1/30 horsepower)

HEATERS

H1	Tube V10 (100 w)
H2	Tube V11 (100 w)
H3	Tube V12 (100 w)
H4	Tube V13 (100 w)
H5	Crystal (2,000 ohms, 40 w)

RECTIFIERS

SR1, SR2	Bias and relay (¼ amp, 120 v d-c)

RELAYS

E1	A-N and identification signal keyer
E2	Link circuit
E3	Thermal overload
E4	Filament contactor
E5	Time delay
E6	Plate contactor
E7	Remote control voice-range switch-over
E8	Main plate overload
E9	Remote power control
E10	Tone-voice switch-over
E11	Quarter-phasing

PILOTS

P1	Filament (6 w, 120 v)
P2	Plate (6 w, 120 v)

RESISTORS

R3	Intermediate p-a grid bias (25,000 ohms, 2 w)
R5	Intermediate p-a screen dropping (3,000 ohms, 2 w)
R14	Auxiliary plate rectifier bleeder (3,000 ohms, 60 w)
R15	Auxiliary plate rectifier bleeder (2,000 ohms, 60 w)
R16	Auxiliary plate rectifier bleeder (3,000 ohms, 60 w)
R17	Audio amplifier cathode bias (200 ohms, 20 w)
R18	Bias voltage regulator limiting (10,000 ohms, 2 w)
R19	Bias isolator (50,000 ohms, 2 w)
R20	Regulator tube V14 equalizer (500 ohms, 2 w)
R21	Regulator tube V15 equalizer (500 ohms, 2 w)
R22	Regulator tube V16 equalizer (500 ohms, 2 w)
R23	Regulator tube V17 equalizer (500 ohms, 2 w)
R24	Audio oscillator grid limiter (100,000 ohms, 2 w)
R25	Audio oscillator cathode bias (1,000 ohms, 2 w)
R26	Audio oscillator screen bleeder (25,000 ohms, 2 w)
R27	Audio oscillator screen bleeder (25,000 ohms, 2 w)
R29	Voice gain control (50,000 ohms, dual potentiometer)
R30	Bias isolator (50,000 ohms, 2 w)
R31	Tone gain control (3,000 ohms, dual potentiometer)
R32	L pad series arm (1 ohm, 40 w)
R33	L pad series arm (1 ohm, 40 w)
R34	L pad series arm (2 ohms, 40 w)
R35	L pad series arm (5 ohms, 40 w)

RESISTORS (cont'd)

R36 thru R41	L pad series arm (10 ohms, 40 w)
R42	L pad shunt arm (5 ohms, 40 w)
R43	L pad shunt arm (5 ohms, 40 w)
R44	L pad shunt arm (10 ohms, 40 w)
R45	L pad shunt arm (25 ohms, 40 w)
R46	L pad shunt arm (25 ohms, 40 w)
R47	L pad shunt arm (25 ohms, 40 w)
R48	L pad shunt arm (100 ohms, 40 w)
R49	L pad shunt arm (100 ohms, 40 w)
R50	L pad shunt arm (200 ohms, 40 w)
R51	L pad shunt arm (500 ohms, 40 w)
R52	L pad shunt arm (4,000 ohms, 40 w)
R54	Audio oscillator plate dropping (5,000 ohms, 20 w)
R67	Driver grid (1 megohm, 2 w)
R68	Driver grid (1 megohm, 2 w)

SWITCHES

S2	Local remote
S3	Filament
S4	Voltage regulator cut-out
S5	Keyer
S6	Tone frequency
S10	Left door interlock
S11	Right door interlock
TH1	Tube heater thermostatic
TH2	Fan control thermostatic
TH3	Undertemperature thermostatic
TH4	Overtemperature thermostatic

TRANSFORMERS

T1	Main plate rectifier (pri. 115-230 v; sec. 1,500-0-1,500 v)
T2	Main plate rectifier filament (pri. 115 v; sec. 5 v)
T3	Auxiliary plate rectifier filament (pri. 115 v; sec. 2.5 v)
T4	Auxiliary plate rectifier (pri. 115-230 v; sec. 625-0-625 v)
T5	Filament (pri. 115 v; sec. No. 1 6.3 v; sec. No. 2 10 v; sec. No. 3 10 v)
T6	Relay rectifier (pri. 115-230 v; sec. 100-120-140 v)
T7	Tone input
T10	Relay auto-transformer (230-115 v)
T12	Voice input
VR1	Filament voltage regulator

TUBES

V2	Intermediate power amplifier
V7	Audio amplifier
V8	Audio amplifier
V9	Audio oscillator
V12	Main plate rectifier
V13	Main plate rectifier
V14	Bias voltage regulator
V15	Bias voltage regulator
V16	Bias voltage regulator
V17	Bias voltage regulator

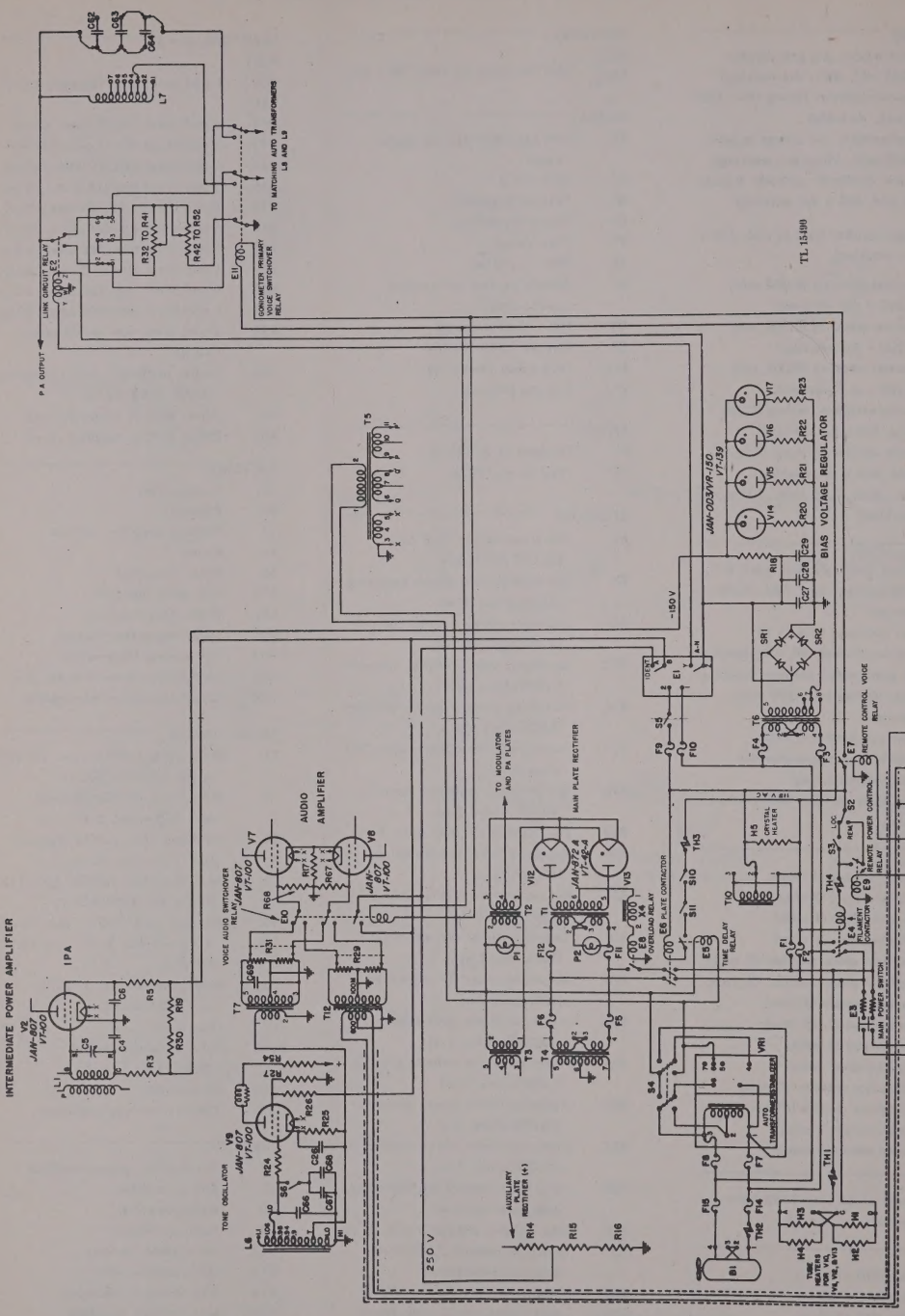


Figure 46. Control circuits, functional diagram.

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C62	Quarter-phasing (0.002 mfd, 1,200 v d-c working)
C63	Quarter-phasing (0.004 mfd, 1,200 v d-c working)
C64	Quarter-phasing (0.008 mfd, 1,200 v d-c working)
C69	Tone filter (0.05 mfd, 300 v d-c working)

COILS

L1	Crystal oscillator tank (pri. 4.7 millihenries; sec. 725 microhenries)
L7	Quarter-phasing (83 microhenries)

RELAYS

E7	Remote control voice-range switch-over
E10	Tone-voice switch-over
E11	Quarter-phasing

RESISTORS

R3	Intermediate p-a grid bias (25,000 ohms, 2 w)
R5	Intermediate power screen dropping (3,000 ohms, 2 w)
R17	Audio amplifier cathode bias (200 ohms, 20 w)
R19	Bias isolator (50,000 ohms, 2 w)
R29	Voice gain control (50,000 ohms, dual potentiometer)
R30	Bias isolator (50,000 ohms, 2 w)
R31	Tone gain control (3,000 ohms, dual potentiometer)
R67	Driver grid (1 megohm, 2 w)
R68	Driver grid (1 megohm, 2 w)

TRANSFORMERS

T7	Tone input
T10	Relay auto-transformer
T12	Voice input

TUBES

V2	Intermediate power amplifier
V7	Audio amplifier
V8	Audio amplifier

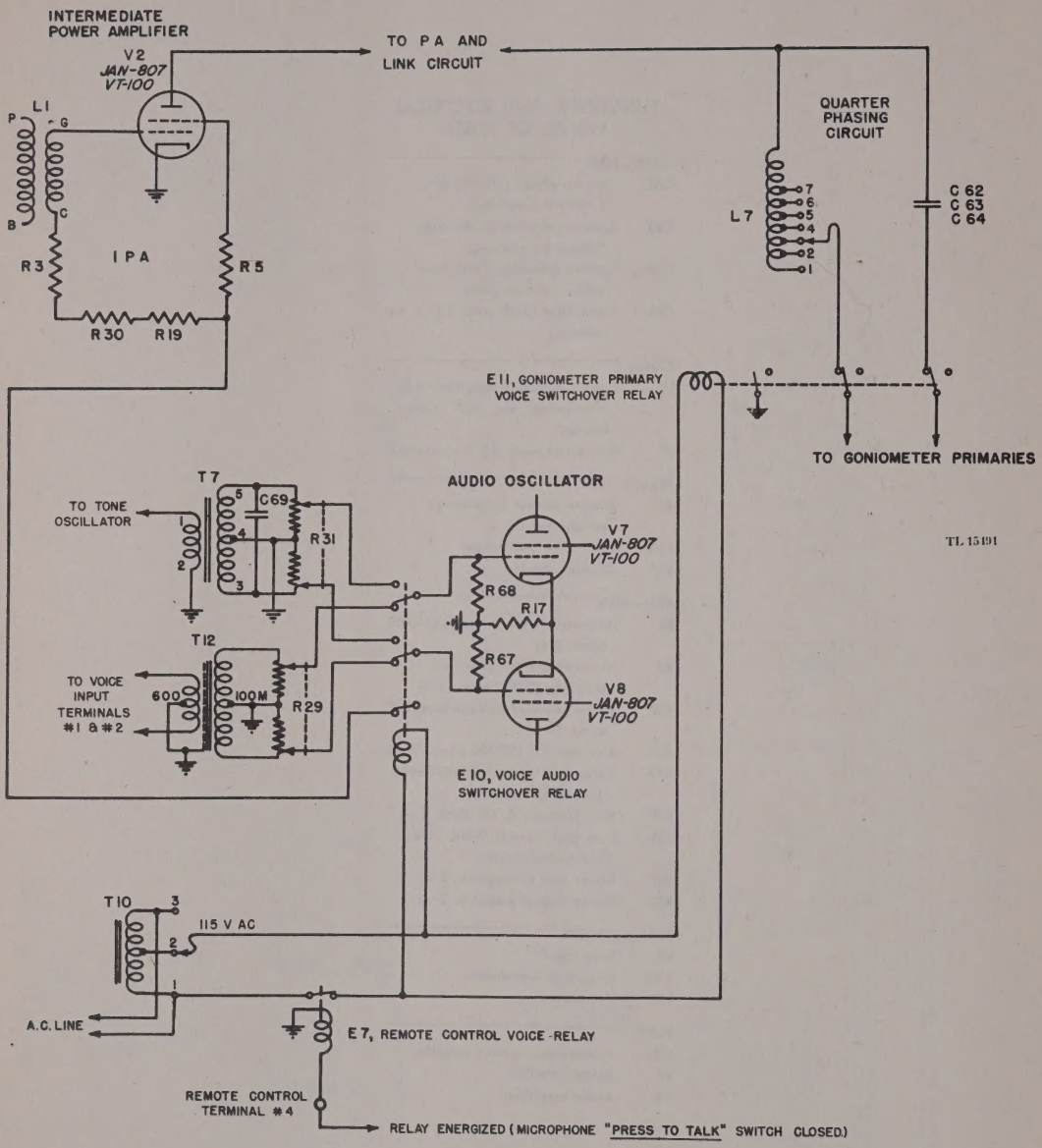
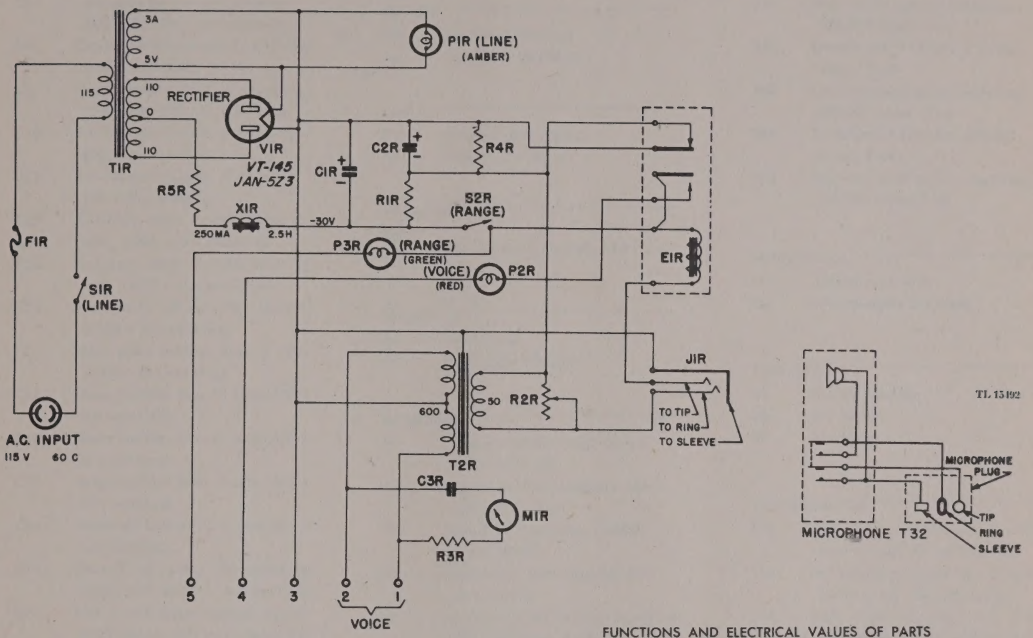


Figure 47. Voice operation, functional diagram.



FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C1R	Rectifier filter (50 mfd, 100 v d-c working)
C2R	Microphone filter (200 mfd, 50 v d-c working)
C3R	Meter blocking (4 mfd, 100 v d-c working)

COIL

X1R	Filter choke (2.5 h)

FUSE

F1R	A-c line (1 amp)

JACK

J1R	Microphone

METER

M1R	Audio line level

PILOTS

P1R	A-c line (6 v)
P2R	Voice (35 v)
P3R	Range (35 v)

SWITCHES

S1R	A-c line on-off
S2R	Range on-off

RELAY

E1R	Press-to-talk

RESISTORS

R1R	Microphone dropping (250 ohms, 25 w)
R2R	Microphone level control rheostat (5-500 ohms)
R3R	Meter multiplier (2,500 ohms, 2 w)
R4R	Microphone bleeder (250 ohms, 25 w)
R5R	Rectifier dropping (100 ohms, 25 w)

TRANSFORMERS

R1R	Power (115/5, 220 v center tapped)
T2R	Microphone to line

TUBE

V1R	Rectifier

Figure 48. Remote Control Unit RM-45-A, schematic diagram.

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

- **C1** Crystal oscillator cathode bypass (0.01 mfd, 600 v d-c working)
- **C2** Crystal oscillator screen bypass (0.01 mfd, 600 v d-c working)
- **C3** Intermediate p-a grid coupling (0.01 mfd, 1,200 v d-c working)
- **C4** Intermediate p-a grid bypass (0.01 mfd, 600 v d-c working)
- **C5** Crystal oscillator tuning (40-1,050 mmfd, variable)
- **C6** Intermediate p-a screen bypass (0.01 mfd, 600 v d-c working)
- **C12** P-a filament bypass (0.01 mfd, 600 v d-c working)
- **C13** P-a filament bypass (0.01 mfd, 600 v d-c working)
- **C22** Auxiliary plate rectifier filter (6 mfd, 1,000 v d-c working)
- **C23** Auxiliary plate rectifier filter (6 mfd, 1,000 v d-c working)
- **C24** Main plate rectifier filter (6 mfd, 2,000 v d-c working)
- **C25** Main plate rectifier filter (6 mfd, 2,000 v d-c working)
- **C27** Relay rectifier filter (4 mfd, 600 v d-c working)
- **C28** Relay rectifier filter (4 mfd, 600 v d-c working)
- **C29** Relay rectifier filter (4 mfd, 600 v d-c working)
- **C65** Meter M1 bypass (0.01 mfd, 600 v d-c working)
- **C70** Modulation meter M2 blocking (0.01 mfd, 2,000 v d-c working)
- **C71** Link circuit meter rectifier bypass (500 mmfd, 500 v d-c working)
- **C72** Left goniometer secondary meter rectifier bypass (500 mmfd, 500 v d-c working)
- **C73** Right goniometer secondary meter rectifier bypass (500 mmfd, 500 v d-c working)

COILS

- **L1** Crystal oscillator tank (pri. 4.7 millihenries; sec. 725 microhenries)
- **L2** P-a coupling (pri. 4.7 millihenries; sec. 620 microhenries)
- **L4** Link circuit coupling variometer (pri. 23.5 microhenries; 185 microhenries)
- **X3** P-a plate choke (15 millihenries)
- **X4** Main plate rectifier filter choke (6 h)
- **X5** Auxiliary plate rectifier filter choke (8 h)

CRYSTALS

- **CR1, CR2** Frequency control

FUSES

- **F5** Auxiliary plate rectifier (3 amp)
- **F6** Auxiliary plate rectifier (3 amp)
- **F11** Main plate rectifier (5 amp)
- **F12** Main plate rectifier (5 amp)
- **F13** D-c meter (1/100 amp)

METERS

- **M1** D-c meter (0-1 ma)
- **M2** A-c meter (0-150 v)

PILOTS

- **P1** Filament (6 w, 120 v)
- **P2** Plate (6 w, 120 v)

RECTIFIERS

- **SR1, SR2** Bias and relay (¼ amp, 120 v d-c)

RELAYS

- **E2** Link circuit
- **E8** Main plate overload

RESISTORS

- **R1** Crystal oscillator grid bias (1 megohm, 2 w)
- **R2** Crystal oscillator cathode bias (400 ohms, 2 w)
- **R7** Modulation metering (50,000 ohms, 60 w)
- **R8** Modulation metering (50,000 ohms, 60 w)
- **R9** Auxiliary plate rectifier metering (500,000 ohms, 2 w)
- **R10** Auxiliary plate rectifier metering (500,000 ohms, 2 w)
- **R11** Main plate rectifier bleeder (20,000 ohms, 60 w)
- **R12** Main plate rectifier bleeder (20,000 ohms, 60 w)
- **R13** Main plate rectifier bleeder (20,000 ohms, 60 w)
- **R14** Auxiliary plate rectifier bleeder (3,000 ohms, 60 w)
- **R15** Auxiliary plate rectifier bleeder (2,000 ohms, 60 w)
- **R16** Auxiliary plate rectifier bleeder (3,000 ohms, 60 w)
- **R18** Bias voltage regulator limiting (10,000 ohms, 2 w)
- **R28** Relay rectifier metering (250,000 ohms, 2 w)
- **R55** Crystal oscillator plate metering (50 ohms, 2 w)
- **R56** Intermediate p-a plate metering (10 ohms, 2 w)
- **R57** P-a cathode metering (5 ohms, 2 w)

RESISTORS (cont'd)

- **R58** Modulator cathode metering (5 ohms, 2 w)
- **R59** Main plate rectifier metering (63 ohms, 2 w)
- **R60** Transformer L12 load (10,000 ohms, 2 w)
- **R61** Link circuit current metering (30,000 ohms, 2 w)
- **R62** Transformer L13 load (10,000 ohms, 2 w)
- **R63** Left antenna current metering (80,000 ohms, 2 w)
- **R64** Transformer L14 load (10,000 ohms, 2 w)
- **R65** Right antenna current metering 80,000 ohms, 2 w)

SUPPRESSORS

- **G1** Crystal oscillator
- **G2** Intermediate p-a plate

SWITCHES

- **S1** Crystal selector
- **S8** D-c meter
- **S9** A-c meter

TRANSFORMERS

- **L12** Link circuit current (pri. 5 microhenries; sec. 13 millihenries)
- **L13** Left antenna current (pri. 5 microhenries; sec. 13 millihenries)
- **L14** Right antenna current (pri. 5 microhenries; sec. 13 millihenries)
- **T1** Main plate rectifier
- **T2** Main plate rectifier filament
- **T3** Auxiliary plate rectifier filament
- **T4** Auxiliary plate rectifier
- **T5** Filament
- **T6** Relay rectifier
- **T9** Modulation
- **VR1** Filament voltage regulator

TUBES

- **V1** Crystal oscillator
- **V2** Intermediate power amplifier
- **V3** Power amplifier
- **V4** Power amplifier
- **V5** Modulator
- **V6** Modulator
- **V10** Auxiliary plate rectifier
- **V11** Auxiliary plate rectifier
- **V12** Main plate rectifier
- **V13** Main plate rectifier
- **V18** Link circuit meter rectifier
- **V19** Left goniometer meter rectifier
- **V20** Right goniometer meter rectifier

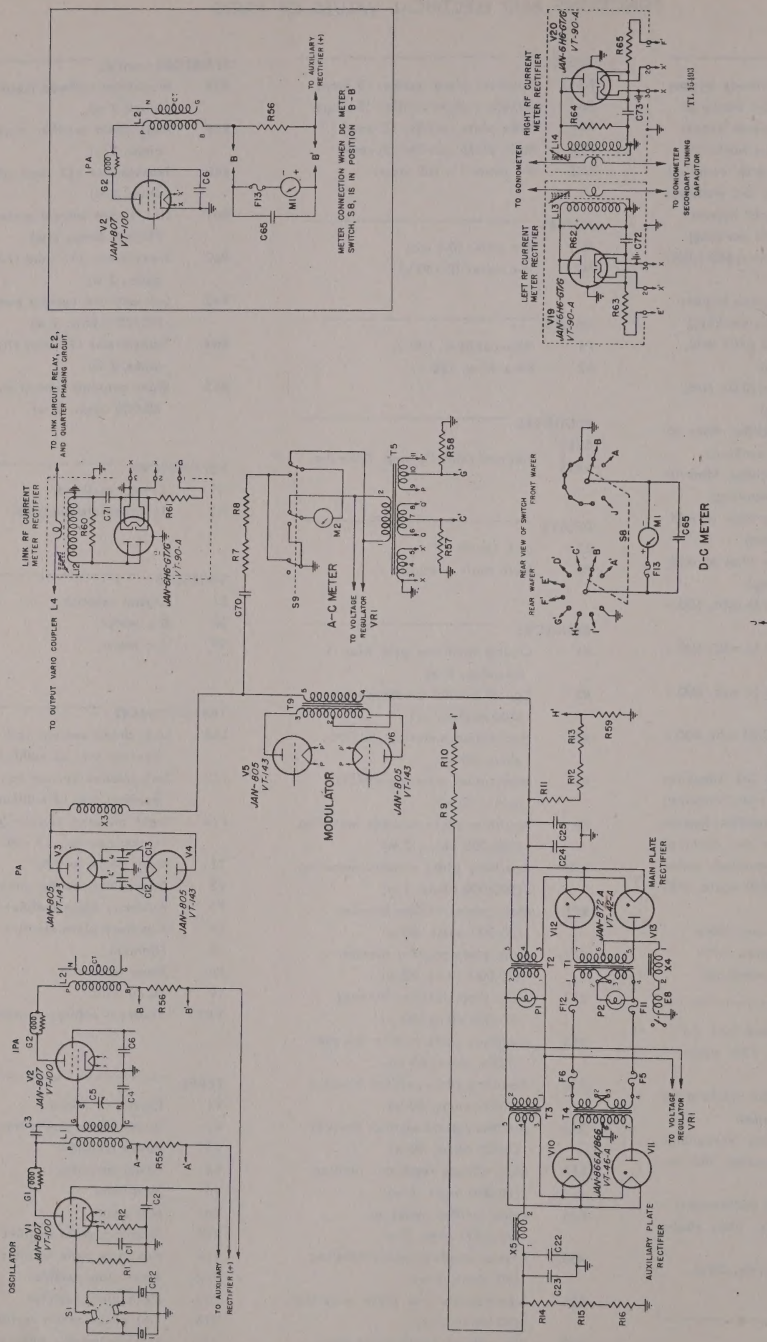


Figure 49. Metering circuits, functional diagram.

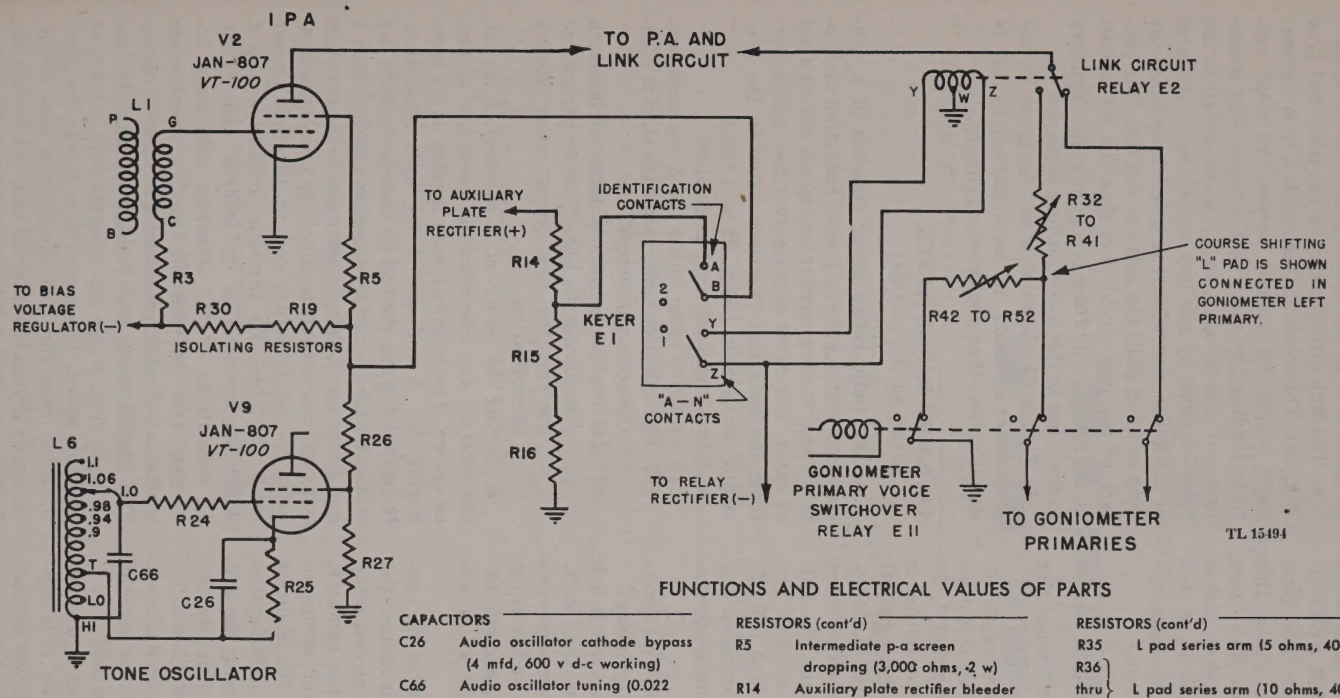


Figure 50

Figure 50. Keyer operation, functional diagram.

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C26	Audio oscillator cathode bypass (4 mfd, 600 v d-c working)
C66	Audio oscillator tuning (0.022 mfd, 300 v d-c working)

COILS

L1	Crystal oscillator tank (pri. 4.7 millihenries; sec. 725 microhenries)
L6	Tone oscillator tank (1 h)

RELAYS

E1	A-N and identification signal keyer
E2	Link circuit
E11	Quarter-phasing

RESISTORS

R3	Intermediate p-a grid bias (25,000 ohms, 2 w)
R5	Intermediate p-a screen dropping (3,000 ohms, 2 w)
R14	Auxiliary plate rectifier bleeder (3,000 ohms, 60 w)
R15	Auxiliary plate rectifier bleeder (2,000 ohms, 60 w)
R16	Auxiliary plate rectifier bleeder (3,000 ohms, 60 w)
R19	Bias isolator (50,000 ohms, 2 w)
R24	Audio oscillator grid limiter (100,000 ohms, 2 w)
R25	Audio oscillator cathode bias (1,000 ohms, 2 w)
R26 thru R27	Audio oscillator screen bleeder (25,000 ohms, 2 w)
R30	Bias isolator (50,000 ohms, 2 w)
R32	L pad series arm (1 ohm, 40 w)
R33	L pad series arm (1 ohm, 40 w)
R34	L pad series arm (2 ohms, 40 w)
R35	L pad series arm (5 ohms, 40 w)
R36 thru R41	L pad series arm (10 ohms, 40 w)
R42	L pad shunt arm (5 ohms, 40 w)
R43	L pad shunt arm (5 ohms, 40 w)
R44	L pad shunt arm (10 ohms, 40 w)
R45	L pad shunt arm (25 ohms, 40 w)
R46	L pad shunt arm (25 ohms, 40 w)
R47	L pad shunt arm (25 ohms, 40 w)
R48	L pad shunt arm (100 ohms, 40 w)
R49	L pad shunt arm (100 ohms, 40 w)
R50	L pad shunt arm (200 ohms, 40 w)
R51	L pad shunt arm (500 ohms, 40 w)
R52	L pad shunt arm (4,000 ohms, 40 w)

TUBES

V2	Intermediate power amplifier
V9	Audio oscillator

b. A-C Meter Circuits. A.C. METER M2 indicates a filament primary voltage or modulation voltage, as selected by A.C. METER SWITCH S9. M2 is a standard 150 volt, iron-vane type, low-frequency meter. It is possible to use this meter at audio frequencies because the large dropping resistor used (100,000 ohms) makes the reactance of the meter negligible up to several thousand cycles. (It is the meter reactance which limits its normal use to 125 cps.)

43. RADIO RANGE SIGNAL CIRCUITS

a. In normal range operation the transmitter produces the following signal cycle:

(1) Twelve A-N interlocks occupying an interval of 1/2 minute. During this time the carrier is modulated at either 1,020 or 500 cps and the transmitter output is transferred back and forth between left and right goniometer primaries, forming a total of 12 N's in the left primary and 12 A's in the right primary (fig. 50).

(2) Transmitter output is put into left primary and keyed once with the identification characters. Both modulation and carrier are keyed simultaneously. Operation occupies 1/16 minute.

(3) Same as second period, except transmitter output is put into right primary.

b. The total time for one complete cycle is 5/8 minute. This sequence is known as the "A-N, long letter identification cycle". Other sequences are possible by using different cams on the keyer E1. The long letter sequence is standard for Radio Transmitter BC-446-J and fills all anticipated requirements.

c. Electrically the radio range keyer E1 contains only two sets of contacts which connect the external circuits. These are the link circuit relay contacts and the identification keying contacts. The mechanical system of the keyer serves to activate them in such a manner that the sequence outlined above is produced. The identification keying contacts function by connecting the 250 volt tap on the auxiliary plate rectifier to the screen supply leads of the i-p-a tube V2 and the tone oscillator tube V9. When these contacts are open, blocking bias is applied to the screens through isolating resistors R19 and R30.

d. The driving motor of the keyer is a small 115 volt, 60 cycle, synchronous motor. It is supplied with power from T10 through one contact of E4. Fuses F9 and F10 are time delay type fuses, to permit the starting of the keyer at low temperatures at which the gear case oil is stiff.

e. The link circuit relay is the polarized type (fig. 86). The field coil (terminals Z to W) is normally connected directly across the relay rectifier holding the relay to the right. The armature coil (terminals Z to Y) is connected to the relay rectifier by the link circuit relay contacts of the keyer, and when energized, overcomes the field coil and pulls the relay to the left. The contact of the link circuit switches the r-f output of the link circuit from one goniometer primary to the other in the A-N interlock sequence.

f. Figure 51 shows how an A signal in one goniometer primary is accompanied by an N signal in the other goniometer primary.

44. RADIO RANGE KEYER
(Figs. 52, 53, and 54)

a. The radio range keyer consists of a synchronous motor driving a gear reduction and intermittent motion mechanism which drives a set of cams. The cams operate switches which perform the electrical functions listed in the preceding paragraph. (Figs. 85 and 109.)

b. Three cams are used as follows:

(1) Interlock cam: forms the A-N characters.

(2) Identification cam: forms the station identification characters.

(3) Interval cam: cuts out action of interlock cam during the identification period and controls the link circuit relay during identification.

c. During the period of A-N interlock signal, the interval and identification cams are at rest as shown. The interlock cam rotates at 24 rpm, keying one A and one N for each revolution. Note that N's are formed by closing contacts *k-j* while A's are formed by the intervals in which *k* and *j* are open. Contact *k* connects to the negative relay rectifier output (nominal 110 v d-c) and *j* connects to the armature coil of the link circuit relay (terminal Y) through contacts *c* and *d* which are operated by the interval cam. When 12 revolutions of the interlock cam have occurred, the intermittent motion mechanism starts the identification and the interval cams. The identification cam rotates at slightly less than 15 rpm, while the interval cam rotates at half this speed. The mechanism drives the identification cam for two revolutions and simultaneously drives the interval cam one revolution. During the first half revolution of the inter-

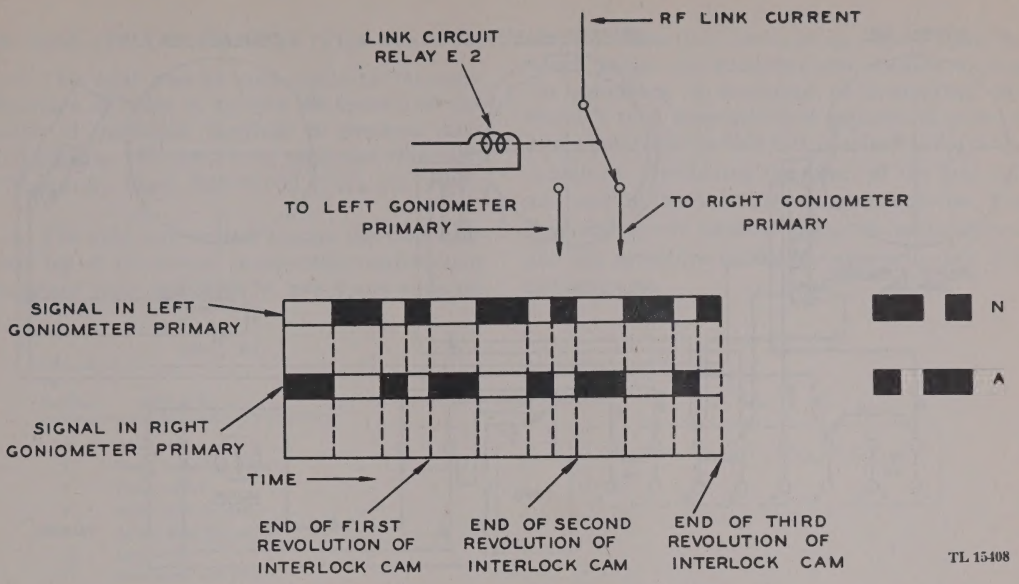

RF LINK CURRENT
LINK CIRCUIT RELAY E 2
TO LEFT GONIOMETER PRIMARY
TO RIGHT GONIOMETER PRIMARY
SIGNAL IN LEFT GONIOMETER PRIMARY
SIGNAL IN RIGHT GONIOMETER PRIMARY
TIME
N
A
END OF FIRST REVOLUTION OF INTERLOCK CAM
END OF SECOND REVOLUTION OF INTERLOCK CAM
END OF THIRD REVOLUTION OF INTERLOCK CAM
TL 15408
RF IN ONE GONIOMETER PRIMARY IS SIMULTANEOUSLY ACCOMPANIED BY ABSENCE OF RF IN OTHER GONIOMETER PRIMARY

Figure 51. Formation of an A-N interlock signal.

val cam, contacts *a* and *b* will be closed keeping terminal Y on the link circuit relay energized and hence holding the link circuit relay to the left or N side. Contacts *e* and *f* will be open and permit identification contacts *g* and *h* to key the transmitter through the TRANS. terminals A and B.

d. On the second half of the interval cam revolution the riding finger drops to the lower level opening contacts *a* and *b*, but keeping *c* and *d* and *e* and *f* open. This de-energizes the link circuit relay armature, allowing it to stay on the right or A side. The second identification cam rotation keys the transmitter during this interval.

e. After this keying is completed, the interval cam finger drops another notch for a brief interval, closing *c* and *d* so that the interlock cam takes over operation of the link circuit relay again, but holding *e* and *f* open so that the transmitter is muted. After this brief interval, the interval cam finger drops into the deep notch and the interval cam and identification cam stop. Contacts *e* and *f*, and *c* and *d* are again closed, and the A-N interlock is transmitted for another 12 cycles.

f. The mechanical system which produces these motions is shown schematically (fig. 53). It functions as follows:

(1) The motor shaft revolves at a speed of 1,800 rpm which is reduced by means of a 75 to 1 worm and wheel reduction (7 and 8) from 1,800 rpm to 24 rpm.

(2) The interlock cam is located on the 24 rpm shaft, and revolves continuously at this speed.

(3) The speed from this shaft is again reduced by means of a 15 to 1 gear reduction (9 and 10) from 24 rpm to 1.6 rpm.

(4) The 1.6 rpm shaft is directly connected to the driving member 14 of the intermittent drive and driving disc 17.

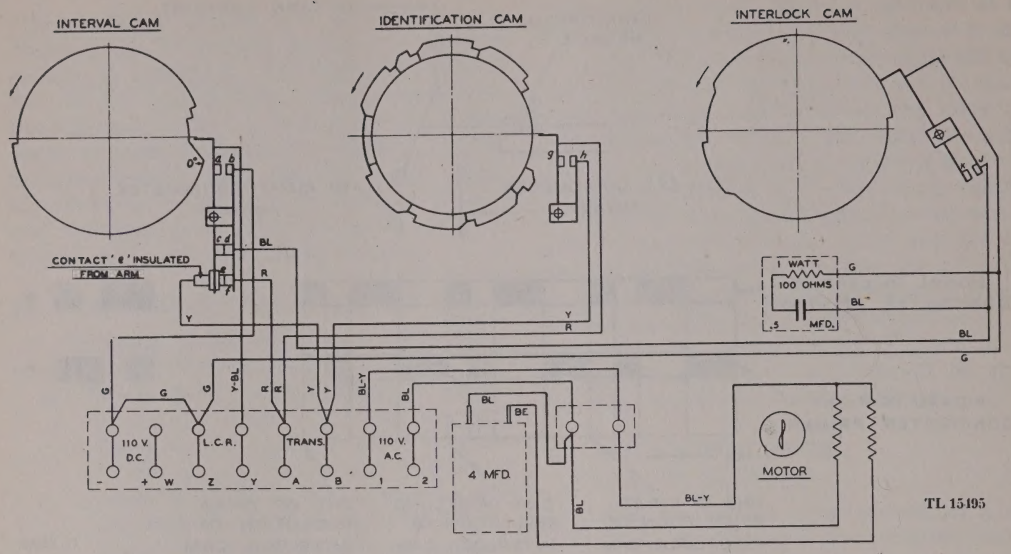


Figure 52. Radio range keyer, schematic diagram.

(5) The driving member 14 drives the driven intermittent gear 15 to which are directly connected the cam driving gear 4 and the 5-segment locking disc 16.

(6) The driven gear 15 makes 1/5 revolution for every one revolution of the driving member 10, 14, and 17.

(7) The gear 4 drives the gears 12 and 13 which have a step-up ratio from gear 4 of 5 to 1 and 10 to 1 respectively.

(8) Therefore, as gear 4 makes 1/5 revolution, gear 12 and interval cam make one revolution, gear 13 and the identification cam make 2 revolutions.

g. The operation to this point is as follows:

(1) The interlock cam revolves continuously at 24 rpm. As the step-down from the interlock shaft to the driven member of of the intermittent drive is 15 to 1, the interlock will make 15 revolutions to one revolution of the intermittent driving member. The driven member of the intermittent drive therefore will be actuated once every 15 revolutions of the interlock shaft and will revolve 1/5 revolution.

(2) The interval cam, being stepped up 5 to 1 from the driven member, will revolve one revolution to every 15 revolutions of the interlock cam.

(3) The identification cam being stepped up 10 to 1, will revolve for 2 revolutions for every 15 revolutions of the interlock cam.

(4) The three shafts, on which the interlock, interval, and identification cams are mounted, revolve at the following speeds:

(*a*) The interlock cam shaft continuously at 24 rpm.

(*b*) The interval cam shaft intermittently at 7.36 rpm for one revolution during every 13th, 14th, and 15th revolution of the interlock cam shaft.

(*c*) The identification cam shaft intermittently at 14.72 rpm for two revolutions during every 13th, 14th, and 15th revolution of the interlock cam shaft.

45. LINK CIRCUIT RELAY E2 (Figs. 54 and 55)

a. This relay uses an unconventional magnetic structure in order to achieve the speed and precision of operation required to produce clean A-N signals. (In continuous operation this relay will operate about 25,000,000 times per year.)

b. The field coil, wound around the rear magnetic leg of the circuit is normally continuously energized from terminals W and Z and pulls the soft iron armature clockwise as viewed from the front. When the armature coil, located around the armature, is energized by connecting terminal Y to Z, magnetic flux, opposite in polarity to the flux from the field coil, is driven through the armature, overcoming the effect of the field coil and pulling the armature counterclockwise. The field coil draws approximately 25 milliamperes and the armature coil draws approximately 200 milliamperes.

Part No.	Description
4	Spur gear
7	Single threaded worm
8	Worm wheel
9	Spiral gear (4 teeth)
10	Spiral gear (60 teeth)
12	Gear shaft
13	Cam plate and pinion
14	Gear sector
15	Spur gear (50 teeth)
16	Locking wheel
17	Driving wheel
18	Shaft
19	Shaft
24	Filler ring
33	Shoulder screw

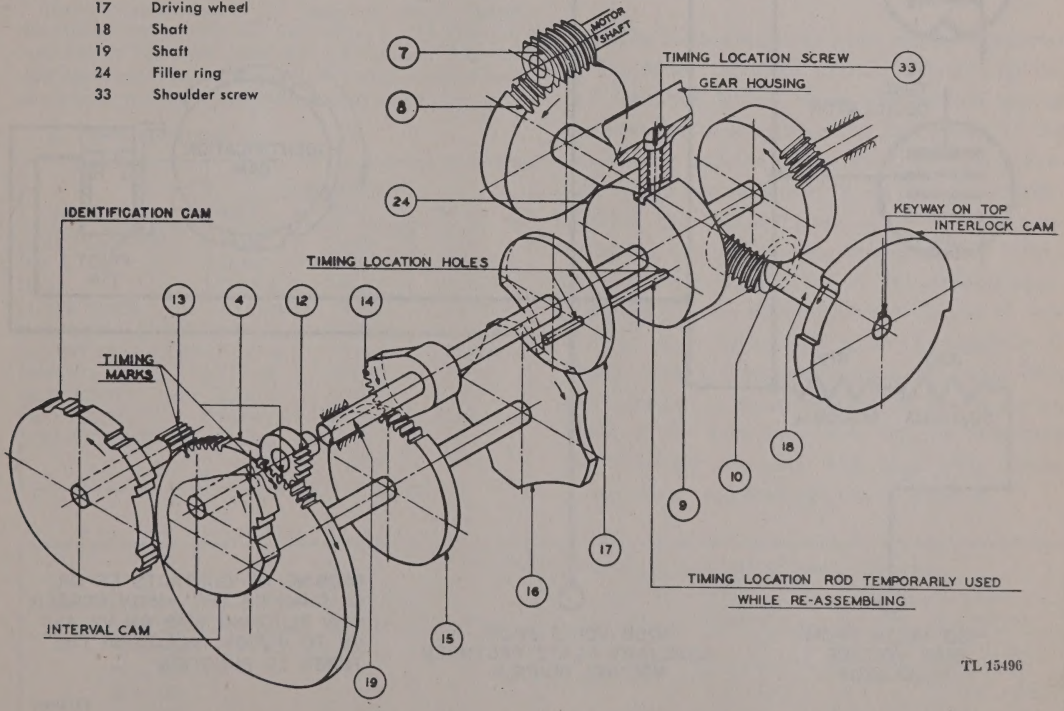


Figure 53. Radio range keyer, mechanical diagram.

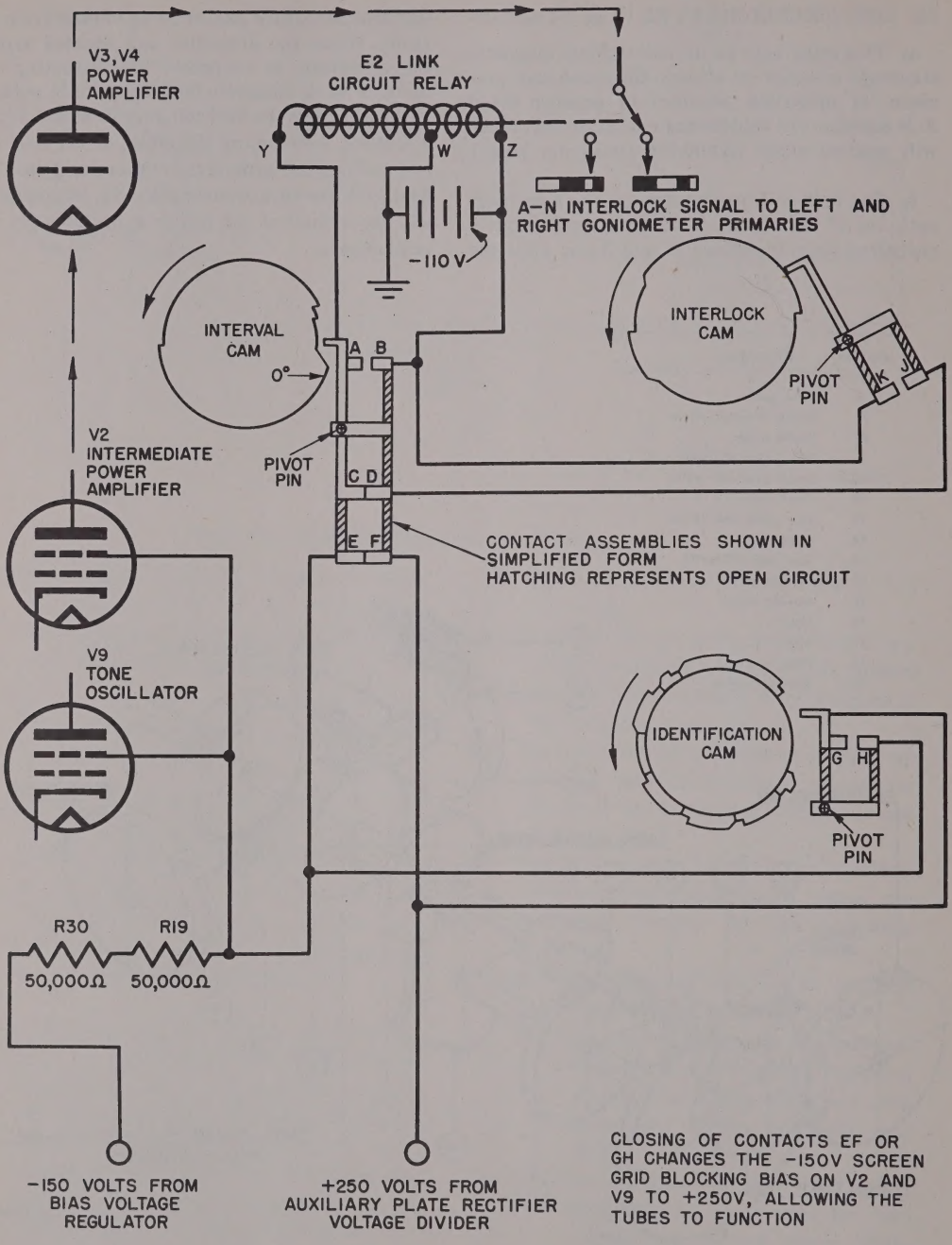


Figure 54. Keying circuits, simplified diagram.

Section IV

MAINTENANCE

46. DAILY INSPECTION

a. Inspect transmitter each operating day. Note condition of lead-in wires and insulators. Keep them clear of vegetation, ice, snow, and heavy dust. Read and record meter readings on all switch positions and compare with tuning chart data. Do not correct regularly changes in meter readings by retuning transmitter. With tower antennas it should never be necessary to retune the transmitter. With loop antennas, retune goniometer secondaries slightly. See trouble chart, paragraph 63. Tuning chart shows actual dial settings. If dials are reset, mark new settings on tuning chart, with date and operator's initials. Maintain oil level in radio range keyer at NORM. Note link circuit relay operation. Report abnormal sparking.

47. TABLE OF NORMAL D-C METER READINGS

NOTE.—Approximately 120 watts of carrier output, modulated 90% at 1,020 cps. Goniometer on 45°. Line voltage 115 or 230 volts. Note that r-f currents with loop operation may vary considerably from those shown here, since loop resistances vary with ground conditions.

a. Loop Antenna.

Switch Point	Loop Antenna		
	200 kc	300 kc	400 kc
CRYSTAL OSC.	12 ma	12 ma	12 ma
I.P.A.	55 ma	55 ma	55 ma
P.A.	210 ma	210 ma	210 ma
LINK CURR.	1.6 amp	1.3 amp	1.15 amp
LEFT SEC. CURR.	2.8 amp	2.3 amp	1.9 amp
RIGHT SEC. CURR.	2.8 amp	2.3 amp	1.9 amp
MODULATOR	200 ma	200 ma	200 ma
M.P. RECT.	1,180 v	1,180 v	1,180 v
A.P. RECT.	490 v	490 v	490 v
RELAY RECT.	100 to 150 v	100 to 150 v	100 to 150 v

b. Tower Antenna.

Switch Point	Tower Antenna		
	200 kc	300 kc	400 kc
CRYSTAL OSC.	12 ma	12 ma	12 ma
I.P.A.	55 ma	55 ma	55 ma
P.A.	210 ma	210 ma	210 ma
LINK CURRENT	1.15 amp	1.15 amp	1.15 amp
LEFT SEC. CURR.	1.25 amp	1.25 amp	1.25 amp
RIGHT SEC. CURR.	1.25 amp	1.25 amp	1.25 amp
MODULATOR	200 ma	200 ma	200 ma
M.P. RECT.	1,180 v	1,180 v	1,180 v
A.P. RECT.	490 v	490 v	490 v
RELAY RECT.	100 to 150 v	100 to 150 v	100 to 150 v

48. TABLE OF NORMAL D-C METER FLUCTUATIONS DURING OPERATION OF TOWER ANTENNAS

a. The radio-frequency currents, as measured by the meter rectifiers, and as indicated by the D.C. METER will fluctuate during A-N keying between limits determined by the setting of the goniometer and the course shifting L pad. Normal values are indicated in the following table. PRESS TO TALK switch open. Noninductive resistors, 35 ohms each, connected to output terminals 9 to G, and 12 to G. Transmitter operating at 396 kc. Readings with L pad in left primary were taken with a series resistance of 18 ohms and a shunt resistance of 275 ohms. This corresponds to a course shift of 15°, producing an angle of 75° between closest courses. Readings may fluctuate or vary 0.05 amp from values given below. All readings are in amperes.

Position of goniometer (degrees)	LIMITS OF CURRENT FLUCTUATIONS (Amperes)					
	Link Curr.		Left Sec. Curr.		Right Sec. Curr.	
	L pad in	L pad out	L pad in	L pad out	L pad in	L pad out
0 or 180	1.15	1.15	0 - 1.75	0 - 1.4	1.75 - 0	1.7 - 0
30 or 210	1.15	1.15	0.9 - 1.5	0.9 - 1.2	1.5 - 0.9	1.5 - 0.7
45 or 225	1.15	1.15	1.2	1.0 - 1.25	1.2	1.25 - 1.0
60 or 240	1.15	1.15	1.5 - 0.9	1.5 - 0.7	0.9 - 1.5	0.8 - 1.2
90 or 270	1.15	1.15	1.75 - 0	1.7 - 0	0 - 1.75	0 - 1.35

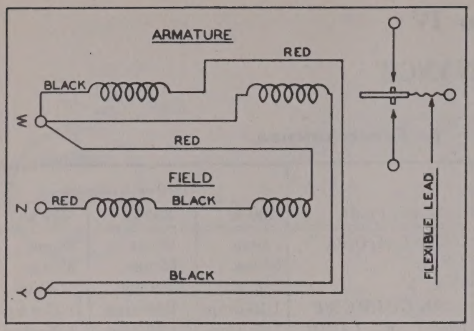


Figure 55. Link circuit relay, schematic diagram.

49. RELAY MAINTENANCE

a. With the exception of link circuit relay E2 and keyer, none of the relays require routine maintenance. If excessive sparking develops, try cleaning contacts with carbon tetrachloride and wipe them dry. If this does not thoroughly clean the contacts, use crocus cloth. In general, the relays used will give best service if they are not touched until obvious trouble develops.

50. LUBRICATING THE KEYER AND BLOWER (Figs. 56 and 57.)

a. The rear bearing of the motor should be packed every 512 hours with WB Grease, General Purpose No. 2, QMC, U. S. Army Spec. No. 2-108 (Amend. 2). To pack this bearing, remove the back bearing cover 76A by removing the four screws 76B. Wipe the bearing, and repack the bearing and recess one-half full with the WB grease. Before replacing the bearing cover, the spring steel washers 76C, which act as spacing shims, should be replaced.

b. Every 8 hours, check the oil in the gear box. The oil should be at the NORM or normal level as marked on the oil gauge glass.

c. Drain the gear box every 1,024 hours by removing drain screw 26A. Take care not to damage gasket 37. Since maximum removal of dirt in sludge is accomplished while the oil is still warm, always drain the gear box immediately following operation of keyer.

d. To refill the gear box with oil remove screw 26 and gasket 37. The gear box should be refilled with approximately 6 ounces of OE oil, Engine, QMC, U. S. Army Spec. No. 2-104-B, SAE 50 to the NORM or normal position on the oil gauge.

e. Test all screws for tightness, especially gear box cover screws 145, every six months to prevent oil leakage.

f. Every 1,024 hours remove the cover over the blower bearing and wipe out the lubricant with a clean cloth. Repack the blower bearing one-half full with WB grease (see foregoing subparagraph **a.**

51. CARE OF THE KEYER CONTACTS (Figs. 58, 59, 60, 61, and 62.)

a. Polishing. The contacts should be cleaned periodically with carbon tetrachloride and then wiped dry. After lengthy periods of operation, the contacts should be polished by placing a piece of crocus cloth between two butting contacts, lightly pressing the contacts together and moving the paper back and forth a few times. The paper should then be reversed to polish the other contact. Files or other course means should not be used.

b. Clearances. Do not tamper with the contacts unless it is absolutely necessary. When doing so, follow these instructions carefully to see whether the proper clearances occur at the contacts. All contact clearances are fixed and no adjustments can be made:

(1) The identification cam switch contacts 206 actuated by the identification cam should be so spaced that the clearance between the contacts is about $\frac{1}{64} \pm 0.008$ inch. If this is not so, replace the contacts.

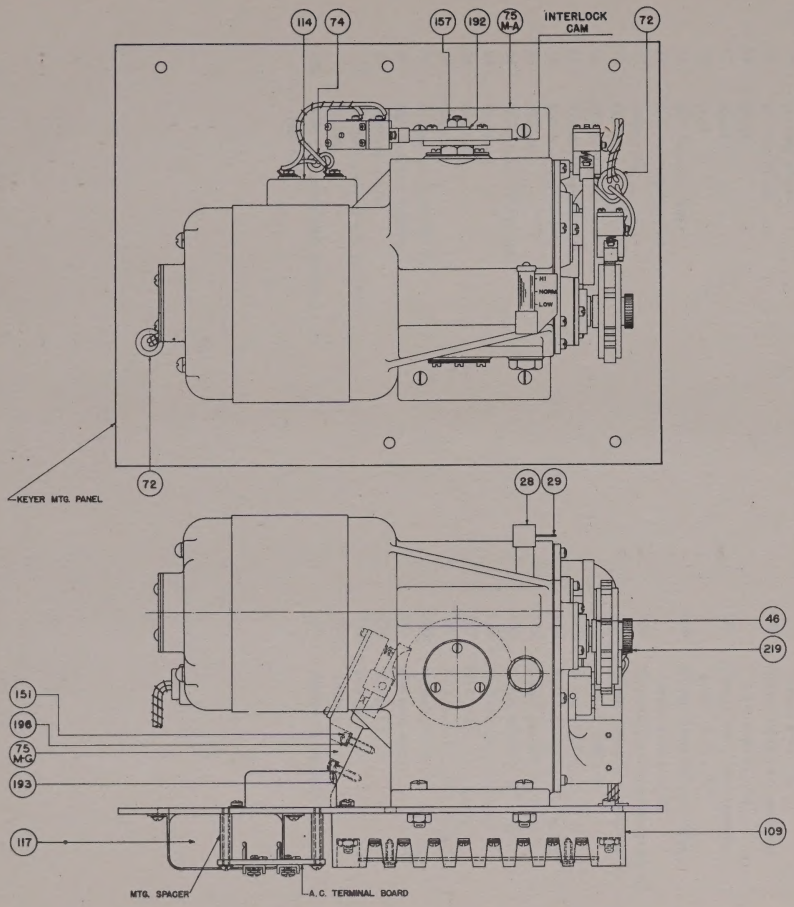
(2) The interlock cam switch contacts 207 actuated by the interlock cam should have a clearance of $\frac{1}{64} \pm 0.008$ inch, when the finger is on the outside rim of the cam or in the open position. If this is not so, replace the contact.

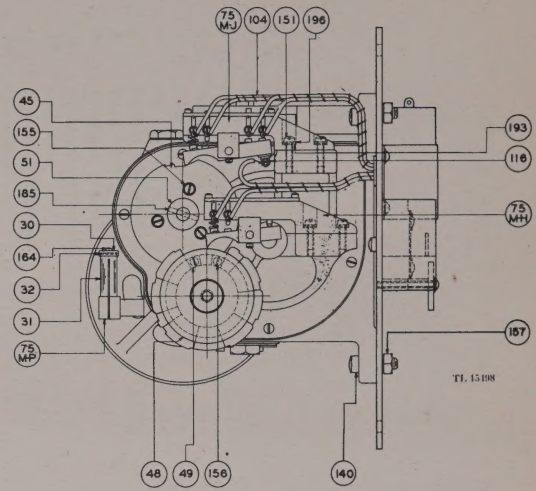
(3) The interval cam switch contacts should have clearance according to the table below when the finger of the interval switch is resting on the second step on the interval cam or in the next to highest position. Replace any contacts that have been worn out.

Clearance between contacts 206: 0.015 ±0.010 inch
Clearance between contacts 207: 0.015 ±0.010 inch
Clearance between contacts 208: 0.065 ±0.015 inch

c. Replacement of Contacts.

(1) To replace movable contacts, remove the top cover plates 64 (fig. 60), 65 (fig. 61), and 202 (fig. 62), from switch by removing the four screws 166. Unsolder the end of the spring 214





Part No.	Description	Part No.	Description
75-M-A	Gear box assembly	116	Zierick terminal No. 13
75-M-G	Interlock switch assembly	117	Capacitor, 4 mfd, 330 v a-c, Cornell Dubilier KG-3040
75-M-H	Identification switch assembly	140	Filister head iron machine screw, ¼-20 x 1"
75-M-J	Interval switch cssembly	151	Filister head iron machine screw, 6-32 x ½"
75-M-P	Oil gauge sub-assembly	155	Filister head iron machine screw, 6-32 x 3/16"
28	Oil gauge body	156	Filister head iron machine screw, 4-40 x 3/16"
29	Gauge plate	157	Hexagon iron nut, ¼-20
30	Oil gauge cap	164	Round head brass machine screw, 4-40 x 1¼"
31	Oil gauge tubing	185	Drill rod pin, 3/32 x ¾"
32	Gasket	192	Brass washer, ¼ x 11/16" OD
45	Interval switch cam, standard	193	Brass washer, No. 6 x 5/16" OD
46	Identification cam plate	196	Shakeproof lockwasher, No. 1206
48	Clamping plate	219	Thumb nut
49	Locking sector		
51	Cam bushing		
72	Wire bushing		
74	Wire bushing		
104	Belden flexible copper wire, No. 18 Ravine		
109	Burke 8-wire terminal block, No. 2008		
114	Capacitor and resistor, Cornell Dubilier NF-10015		

Figure 56. Radio range keyer, main assembly.

Part No.	Description
75-M-P	Oil gauge sub-assembly
1	Gear box
2	Gear box cover
4	Spur gear
7	Single threaded worm
8	Worm wheel
9	Spiral gear (4 teeth)
10	Spiral gear (60 teeth)
12	Gear shaft
13	Cam plate and pinion
14	Gear sector
15	Spur gear (50 teeth)
16	Locking wheel
17	Driving wheel
18	Shaft
19	Shaft
20	Stud
21	Ball bearing stud
23	Ball bearing housing
24	Filler ring
25	Collar
26	Oil fill screw
26A	Oil drain screw
27	Ball bearing cover
33	Shoulder screw
34	Gear box cover gasket
35	Gasket
36	Gasket
37	Gasket
76	Bodine motor (1/30 hp)
79	Ball bearing housing
93	Bearing spacer
105	Garlock seal ⅜ x ¾ x 5/16" wide
106	New Departure ball bearing, No. 38
107	New Departure seal bearing, No. 8103
108	New Departure seal bearing, No. 9500
118	New Departure ball bearing, No. 77500 (double shielded)
119	Motor seal with flange
139	Round head iron machine screw, 8-32 x 4¼" (1" thread)
145	Filister head iron machine screw, 8-32 x ½"
146	Filister head iron machine screw, 6-32 x ⅜"
147	Filister head iron machine screw, 6-32 x 5/16"
149	Filister head iron machine screw, 6-32 x ½"
150	Filister head iron machine screw, 4-40 x 5/16"
160	Stainless steel lockwasher No. 8
175	Filister head iron machine screw, 4-40 x ⅜"
179	Dowel pin R-2, ⅛" x ¾"
180	Dowel pin R-96, ⅛" x 1¼"
182	Dowel pin R-3, ⅛" x ⅞"
183	Dowel pin R-1, ⅛" x ½"
186	Drill rod pin 3/32 x ⅝"
187	Drill rod pin 1/16 x ½"
188	Drill rod pin 3/32 x 5/16"
189	Woodruff key No. 2
217	Oil seal ring
224	Motor fan
227	Gasket
228	Gasket
229	Insulating bushing

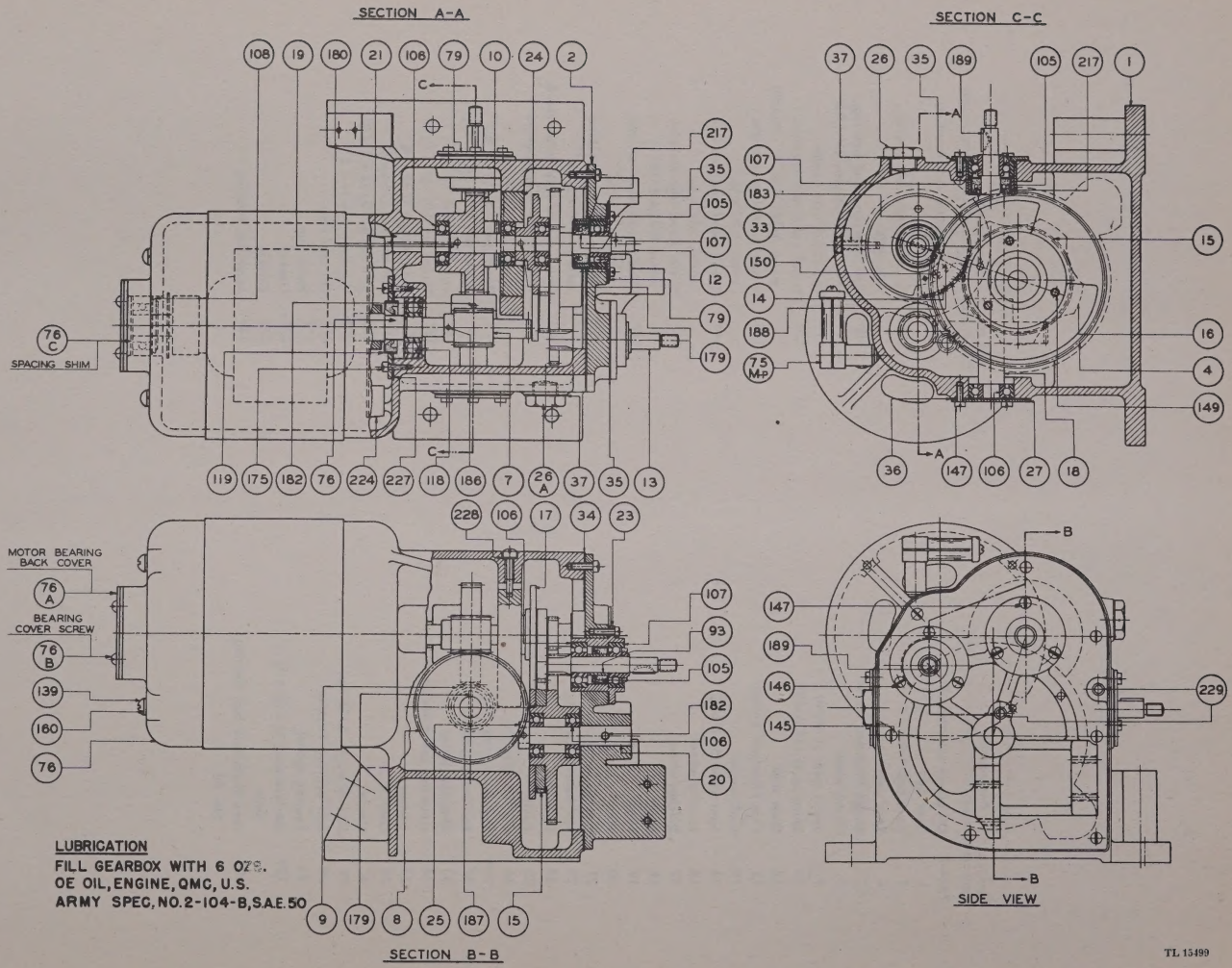


Figure 57. Radio range keyer, gear box assembly.

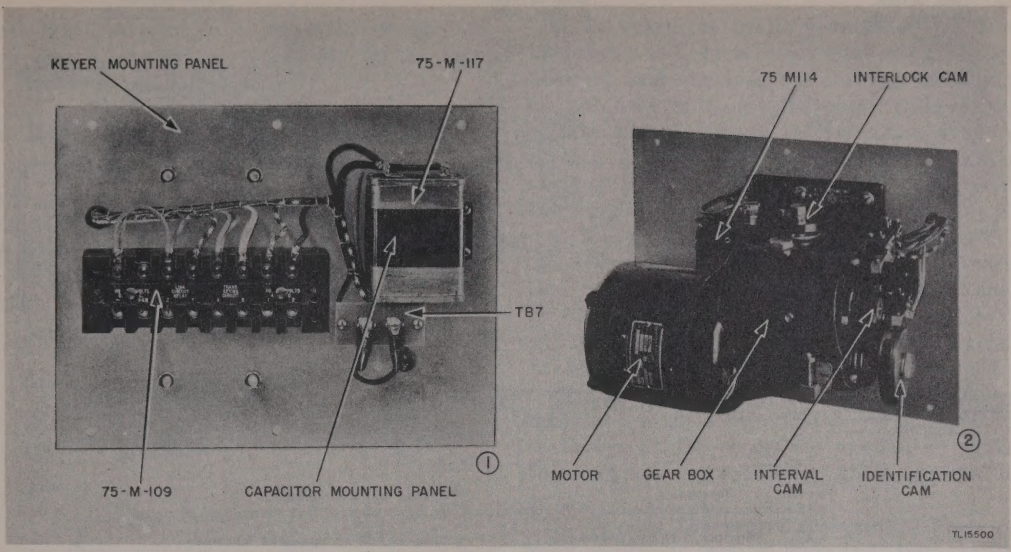


Figure 58. Radio range keyer: ① Front view; ② Rear view.

from the terminal 116 and lift out the contact. Replace with a new contact and spring as the spring is attached to the contact stud at the factory.

(2) Contact 206 or 207 is pressed out from the lever arm and replaced by forcing new contacts in their place. Contact 208 is replaced by removing the two nuts 171 and removing the contact stud, replacing with a new stud.

(3) Springs 213 and 215 are furnished assembled with stud 209. This stud must be driven out in order to remove the spring.

52. REMOVING THE KEYER MOTOR

(Figs. 56 and 57.)

a. Drain the oil from the gear box by removing drain screw 26A.

b. When removing or replacing the motor, take care that the switch finger resting on the interlock cam is lifted clear. The cam will rotate in moving the motor and the switch finger may jam against the wall of the slots in the cam.

c. Remove the motor from the gear box by first disconnecting the motor leads from the terminal block and starting capacitor on the back of the panel and pulling them through the bushing 72.

d. Next remove the four screws 139. Support the motor while this is being done. Now the motor frame may be removed by pulling it straight out from the gear box.

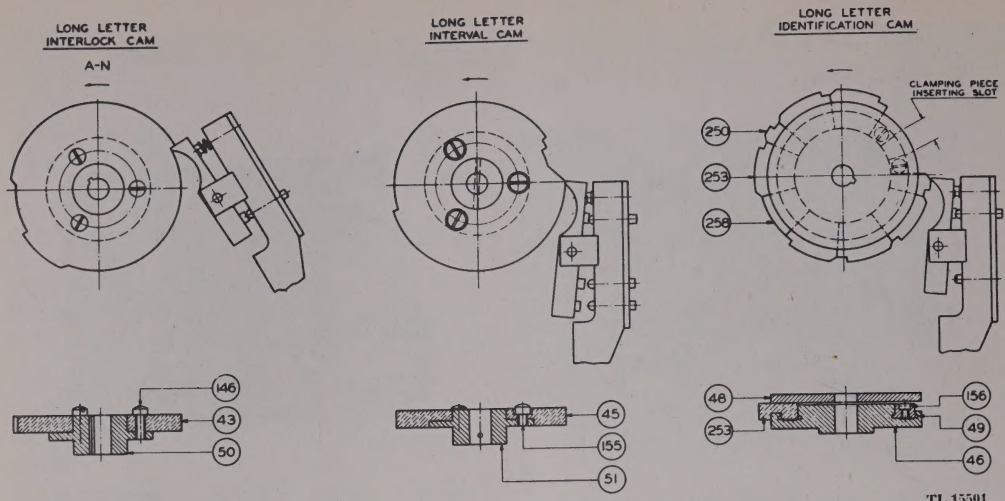
e. To remove the armature, first remove the four screws 175. Then pull the armature straight out, bringing the seal and bearing with it. Take care not to damage gasket 227.

f. In removing or replacing any part where a grease seal has to be removed, replace it with the hollow side of seal toward the inside of the gear box as shown in figure 57 (No. 217).

53. REASSEMBLING THE KEYER MOTOR

a. Insert the armature into the gear box with worm 7, bearing 118, gasket 227, and seal 119 in place, taking care that the worm engages freely with its worm wheel and that the switch finger resting on the interlock cam is lifted clear. Replace the four screws 175, being sure that they are well secured. Replace the motor frame and secure the four screws 139.

b. The amount of end play of the armature is governed by shims 76C under the rear bearing housing cover 76A. All motors are shipped from the factory with the proper spacers in place and should need no attention. In the event that the axial play is either too small or excessive, shims 76C may be added or taken out. The motor armature should turn freely when the motor is in place and the armature end play should not exceed $\frac{1}{64}$ inch.



Part No.	Description	Part No.	Description
43	Interlock A-N cam (standard)	146	Filister head iron machine screw, 6-32 x 3/8"
45	Interval switch cam (standard)	155	Filister head iron machine screw, 6-32 x 3/16"
46	Identification cam plate	156	Filister head iron machine screw, 4-40 x 3/16"
48	Clamping plate	250	Dot segment
49	Locking sector	253	Dash segment
50	Cam bushing	258	Space segment
51	Cam bushing		

Figure 59. Radio range keyer, cam assembly.

54. DISASSEMBLING THE KEYER GEAR BOX (Figs. 56 and 57)

a. Drain oil from box by removing drain screw 26A. Remove the identification and interval switches by removing the screws 151. Remove seven cover screws 145.

b. The coyer may now be removed by pulling it straight out from the gear box. Take care that gasket 34 is not damaged. This cover has mounted on it the intermittent driven gear 15, the stationary locking disc 16, the spur driven gear 4, the interval cam gear 12, the identification cam gear 13, the interval cam, identification cam, and all shafts and bearings necessary to support the above.

c. In removing or replacing any parts where a grease seal has to be removed, it should be placed with the hollow side of the seal toward the inside of the gear box as shown in figure 57 (No. 217).

d. The three gears 4, 12, and 13 have timing marks in the form of small punch marks near one tooth of each gear. When reassembling these gears, these punch marks should be set opposite to one another for proper alignment of the interval, identification, and interlock cam.

e. The gear 15 and locking disc 16 are fastened to the gear 4 by means of three screws 149 and a locating pin 183. Pin 183 should be replaced since it accurately locates the parts with relation to each other. When removing or replacing pins, take care that the part directly under the pin is supported to prevent bending of these parts.

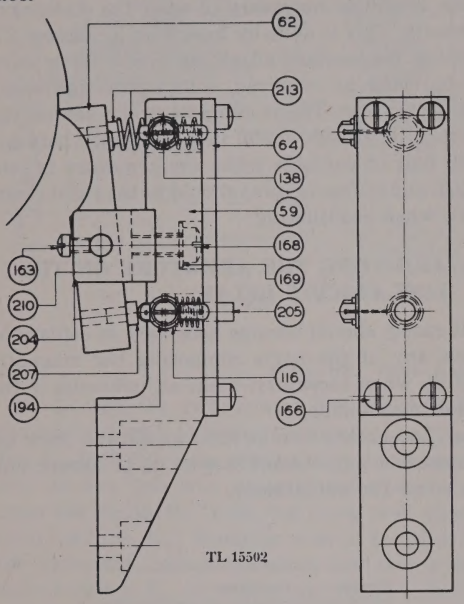
f. The intermittent driving gear 14, the rotating driving disc 17, the filler ring 24, and the gear 10 are all mounted on the shaft 19. To remove these parts, remove the timing location screw 33, grasp the intermittent driving disc 17 and pull out from the gear box. Take care that the pull is straight out as the clearance between the gear 10 and the filler ring in the gear box is small.

g. To remove the shaft 18, take off ball bearing cover 27 and remove the screws from ball bearing cover 79. Drive out pin 182 from gear 8. Then push the shaft and bearing 106 into the

gear box, far enough to remove bearing 106, and gear 8. Shaft 18 and housing 79 can then be removed from the gear box.

55. REASSEMBLING THE KEYER GEAR BOX

a. The shaft 18 should be inserted from the cam end with the housing 79 in place. Place the gear 8 on the shaft and push the bearing housing 79 into its bore with the gasket in place. Push the bearing 106 on the shaft and pin gear 8 in place.



Part No.	Description
59	Interlock switch body
62	Interlock switch lever
64	Interlock switch cover
116	Zierick terminal No. 13
138	Round head brass machine screw, 3-48 x 3/16"
163	Filister head iron machine screw, 2-56 x 1/8"
166	Filister head iron machine screw, 3-48 x 5/16"
168	Filister head iron machine screw, 8-32 x 5/16"
169	Shakeproof lockwasher No. 8
194	Stainless steel lockwasher No. 3
204	Lever bracket
205	Contact pin
207	Contact point
210	Pin
213	Retaining spring

Figure 60. Radio range keyer, interlock switch details.

b. To insert the units mounted on the shaft 19, procure a 1/8 inch rod of steel or brass about 4 inches long and insert it through the timing location holes in the intermittent driving disc 17, and the filler ring 24, as shown on the keyer mechanical diagram (fig. 53). The timing location screw 33 should be screwed in part way so that the end will guide the slot in the filler ring 24.

c. The shaft 18 should then be rotated so that the keyway is about 10 degrees counterclockwise from its upper vertical position. The shaft 19 with all its parts in place, should then be inserted. Take care that the slot of the filler ring engages the screw 33. As this unit is pushed in place, the shaft 18 should rotate so that the key will stand in an approximately vertical position as shown on the schematic mechanical layout. This indicates correct timing of the units to this point.

d. Remove the aforementioned 1/8 inch rod from the timing location holes and screw the timing location screw 33 into the hole at the bottom of the slot in the filler ring 24.

e. The cover should be assembled as described above, and checked to see that the timing marks tally, showing that these parts are correctly timed. Before replacing the cover, see that the surfaces of the gear box and cover on which the gasket 34 rests, are clean. Also note whether the gasket is in good condition and whole. A torn gasket should not be used.

f. Line up one of the five circular cut-outs on the locking disc 16 approximately with the driving disc 17. Push the cover carefully in place, rocking either the identification or interval cam slightly, so that the locking disc will come in mesh. Otherwise the cover will not come in place against the gear box. All screws should be then securely tightened.

56. CHANGING THE SEGMENTS ON THE KEYER IDENTIFICATION CAM (Fig. 59.)

a. The identification letters on the identification cam are set up at the factory. If these letters are to be changed, pull the cam from the shaft, remove cover plate and loosen the two screws 156, thereby releasing the clamping pieces 49. The segments then can be lifted out and and new identification segments inserted.

b. Looking down at the face of the cam with the clamping piece inserting slot at the top, the first segment is placed near the right-hand edge of the inserting slot with the remaining seg-

ments following clockwise toward the left-hand edge of the inserting slot. The slope on the segments should incline away from the right-hand edge of the inserting slot. In other words, the last dot or dash of the identification should be near the left-hand edge as shown on the drawing.

c. When all of the identification segments have been placed in the cam, the two clamping pieces 49 can be pushed tightly against the end segments. The segments and clamping pieces should be so centered as to leave an equal space from either side of the inserting slot. The two screws 156 are then tightened, locking the clamping pieces in place.

d. The cam then should be placed on its shaft, with key 189 in place and the cover plate 48 replaced and fastened with the thumb-nut 219.

57. CLEANING AND ADJUSTING CONTACTS ON THE LINK CIRCUIT RELAY

(Figs. 63 and 64.)

a. Two tommy wrenches are furnished with each relay and are normally kept in clips mounted on the relay base for that purpose. These wrenches should be used on all adjusting screws and locknuts except where a screwdriver is necessary. Each relay is completely adjusted before shipment from the factory, and further adjustment in the field should not be required unless made necessary by loosening in transit or replacement of a part.

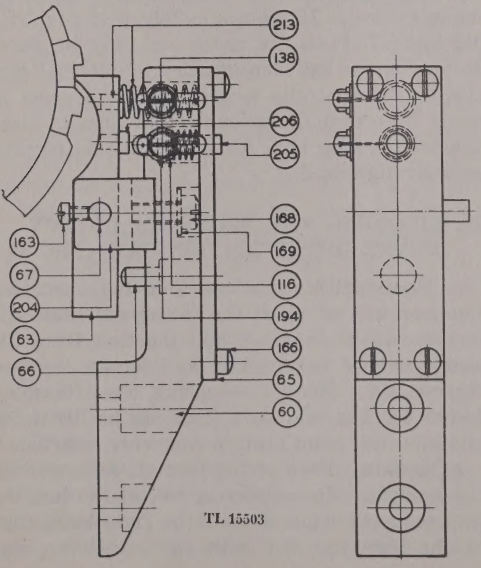
b. The r-f contacts require a periodic cleaning with carbon tetrachloride which should be applied saturated in a strip of blotting paper. If this cleaning is neglected, irregularities will form on the contact surfaces which can only be removed by the use of a sharp abrasive such as Behr-Manning Speed-Wet paper 320. Excessive use of abrasives should be avoided and the thorough cleaning of the contacts periodically with carbon tetrachloride should not be neglected.

c. After considerable use and cleaning of contacts, it will be necessary to reset the stationary contacts. This is done by loosening lockscrew 67, turning the contact adjusting screw 65 inward or outward as required, and again tightening the lockscrew. These contacts were set at the factory to provide 0.002 inch clearance between each pair of contacts when the armature is centered, and the same value should be the right clearance when readjusting.

58. ADJUSTING THE ARMATURE ON THE LINK CIRCUIT RELAY

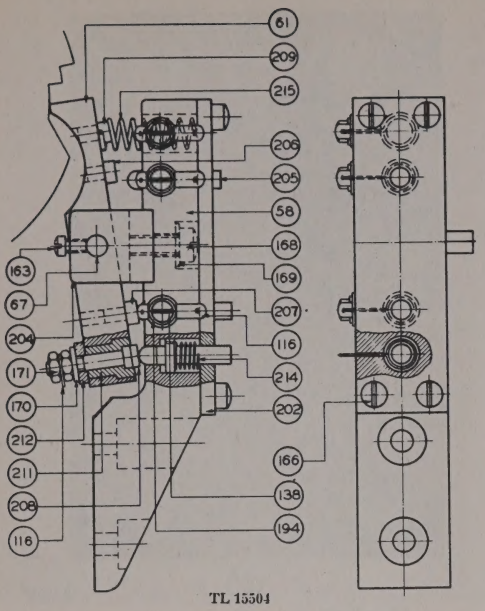
It rarely should become necessary to replace or move any of the parts composing the magnetic circuit, when necessary, make adjustments in the following manner:

a. Loosen the two lockscrews 67 and back off the contact adjustment screws 65 to assure ample room for adjustment.



Part No.	Description
60	Identification switch body
63	Identification switch lever
65	Identification switch cover
66	Identification switch stop pin
67	Pin
116	Zierick terminal No. 13
138	Round head brass machine screw, 3-48 x 3/16"
163	Filister head iron machine screw, 2-56 x 1/8"
166	Filister head iron machine screw, 3-48 x 5/16"
168	Filister head iron machine screw, 8-32 x 5/16"
169	Shakeproof lockwasher No. 8
194	Stainless steel lockwasher No. 3
204	Lever bracket
205	Contact pin
206	Contact point
213	Retaining spring

Figure 61. Radio range keyer, identification switch details.



Part No.	Description
58	Interval switch body
61	Interval switch lever
67	Pin
116	Zierick terminal No. 13
138	Round head brass machine screw, 3-48 x 3/16"
163	Filister head iron machine screw, 2-56 x 1/8"
166	Filister head iron machine screw, 3-48 x 5/16"
168	Filister head iron machine screw, 8-32 x 5/16"
169	Shakeproof lockwasher No. 8
170	Brass washer No. 3
171	Hexagon brass nut 3-48
194	Stainless steel lockwasher No. 3
202	Interval switch cover
204	Lever bracket
205	Contact pin
206	Contact point
207	Contact point
208	Contact pin
209	Spring holder pin
211	Bushing
212	Washer
214	Contact spring
215	Retaining spring

Figure 62. Radio range keyer, interval switch details.

b. Loosen the two screws 259 which fasten the top bracket 2 to the coil bracket 1, and insert two $\frac{3}{64}$ inch diameter rods between the armature and the two pole shoe assemblies furthest away from the contacts. Press the loose pole shoe so as to hold the $\frac{3}{64}$" diameter rods in position and the armature central between the pole pieces. as to hold the $\frac{3}{64}$ inch diameter rods in position and the armature central between the pole pieces. Retighten the screws 259. Screw in the contact adjustment screws 65, and with the aid of a feeler gauge, set them so that approximately 0.002 inch clearance is obtained between each set of contacts. The lock-screws 67 then should be tightened.

c. Remove the $\frac{3}{64}$ inch diameter rods, and, if necessary, make final adjustment of magnetic balance by rotating the entire magnetic assembly as described in paragraph 59**d**.

59. REPLACING CONTACTS ON THE LINK CIRCUIT RELAY

a. To replace a stationary contact, loosen lock-screw 67, back off contact adjustment screw 65, and unscrew stationary contact point 66. Replace one contact at a time to prevent disturbing the setting of the remaining contacts.

b. To replace a movable contact, the complete armature contact assembly must be removed. First, remove the top hexagon nut from the isolantite insulator bushing and lift the moving. contact connector assembly 2-B-H from the isolantite insulator terminal stud. Then loosen the two clamp screws 269 and take out the complete armature contact assembly by pulling the mycalex rod out of the armature insulator clamp. The moving contact assembly 2-B-K can then be removed for replacement by taking out screw 276 which fastens the contact assembly to clamp bracket 78. When replacing it, slip the moving contact insulator 79 far enough into the insulator clamp of armature 2-B-J so that the armature contacts line up horizontally with the stationary contacts. This may be judged by eye. The assembly can be rotated in the insulator clamp and should be turned so that the angles between moving contacts and stationary contacts are equal on the two sides. Then tighten clamping screws 269 to hold it in this position. When the armature is then pushed from one side to the other, it will be noted that the contact is first made near the front edge of the contact material and that this point of contact moves backward as the armature travels further. This point of contact should move over ap-

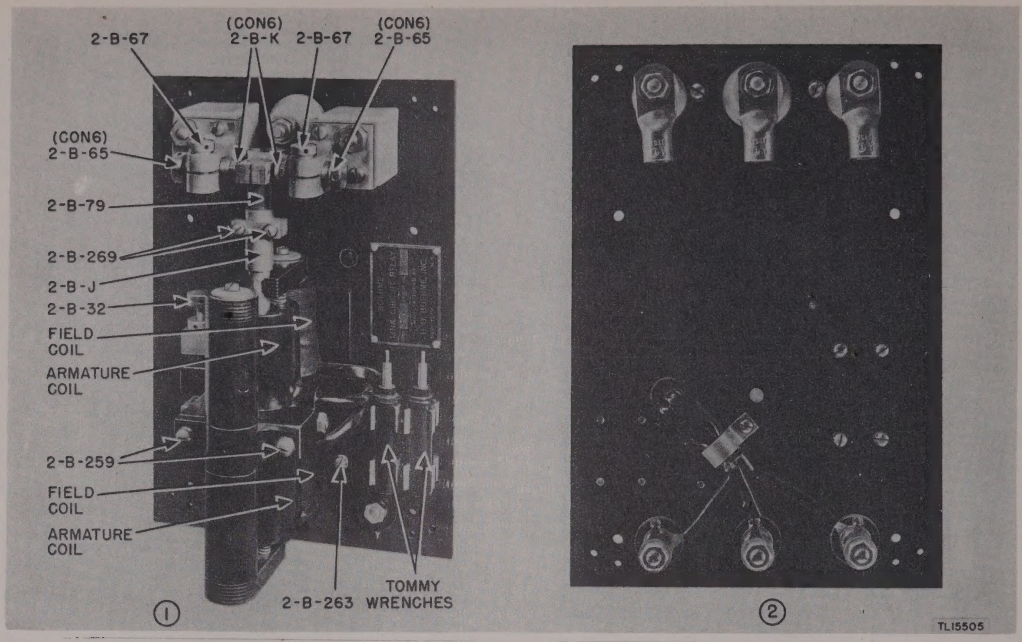


Figure 63. Link circuit relay: ① Rear view; ② Front view.

proximately the same portion of the contact on each side, and if it does not, further adjustment can be made by again loosening the clamping screws slightly and turning the armature contact assembly in the proper direction.

c. After finally clamping the armature contact assembly, the moving contact connector assembly 2-B-H should be replaced and the stationary contacts adjusted so as to allow about 0.002 inch clearance between each pair of contacts when the armature is centered.

d. It may be that the armature is not centered properly in the magnetic field, in which case the operating forces will not be equal in the two directions. Whether or not the magnetic force is approximately equal in each direction when the relay is operated electrically, may be determined by a simple application of finger pressure against either side of the moving armature. If the force is not equal, the entire magnetic assembly may be turned by means of its adjusting screw 32, after first loosening the two screws 263 which fasten the coil bracket 1 to the base plate 87, and locknut 18. The assembly should be rotated so as to increase the air gap on the side showing the greater force.

e. Upon completion of these adjustments, the relay should give satisfactory operation for range keying. However, further minor adjustments of the stationary contacts may be made if necessary to reduce the key clicks or otherwise improve operation.

60. REPLACING ARMATURE COILS ON THE LINK CIRCUIT RELAY

a. When removing the armature coil nearest the contacts, the entire coil bracket must be detached from the base plate 87 by the following procedure: Unsolder the lead wires from terminals 104 at points Y, Z, and W. Remove the following:

1 screw 276
1 wire clamp 83
2 screw 267
1 spring block 30
1 spring 42
2 screw 263
1 nut and washer from top of center isolantite insulator

b. The coil bracket may now be removed from the base plate and the spaghetti slipped off the wires of the coil. The top bracket 2 is then removed by taking out screws 259 and lifting the bracket carefully so that the coil retaining springs 35 are not lost or damaged. Remove the following:

1 screw 264, front field coil
1 washer 27, front field coil
1 pole shoe assembly 2-B-G, front field coil
2 nuts 252
2 setscrews 160

Part No.	Description	Part No.	Description
2-B-A	Field coil assembly	83	Wire clamp
2-B-B	Armature coil assembly	87	Base plate
2-B-G	Pole shoe assembly	88	Bushing
2-B-H	Moving contact connector assembly	89	Washer
		103	Tommy bar clip
2-B-J	Armature	104	Terminal
2-B-K	Moving contact assembly	105	Varnished tubing
1	Coil bracket	106	Varnished tubing
2	Top bracket	111	Varnished tubing
5	Core	112	Varnished tubing
10	Spacer tubing	113	Varnished tubing
15	Armature bearing pin	114	Varnished tubing
18	Lock nut	120	Bushing
27	Washer	160	Screw
30	Spring block	250	Nut
31	Screw block	251	Nut
32	Adjusting screw	252	Nut
33	Tommy bar	253	Washer
35	Coil retaining spring	254	Lockwasher
37	Threaded rod	255	Lockwasher
42	Spring	256	Lockwasher
43	Center pin	257	Lockwasher
45	Name plate	259	Screw
61	Contact bracket insulator	261	Screw
62	Contact terminal insulator	262	Screw
63	Contact bracket, left	263	Screw
64	Contact bracket, right	264	Screw
65	Contact adjustment screw	266	Screw
66	Stationary contact point	267	Screw
67	Lock screw	269	Screw
71	Spacer tubing	270	Screw
72	Wire bushing	272	Set screw
73	Terminal connecting rod	273	Dowel pin
74	Spacer washer	274	Dowel pin
77	Spring backing plate	276	Screw
78	Contact clamp bracket	4-B-9	Armature bearing
79	Moving contact insulator	4-B-12	Special lockwasher

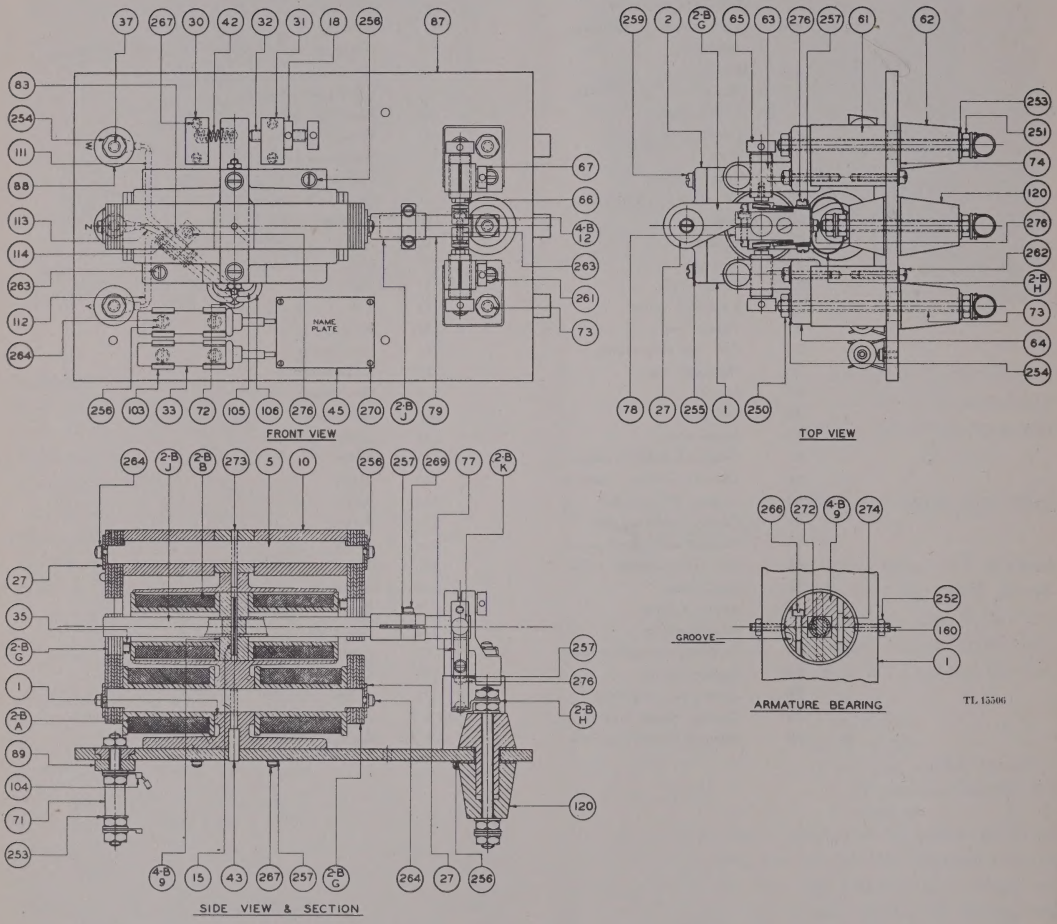


Figure 64. Link circuit relay assembly.

c. The armature bearing is now free to rotate within the coil bracket 1, but not to be extracted. By grasping the armature 2-B-J, rotate the armature bearing 4-B-9 until the groove in it is visible through the hole from which setscrew 271 was removed. The groove must line up with the hole on the same side of the housing which serves as outlet to the coil lead wires.

d. The coil now may be removed by pulling out on the armature 2-B-J, but in this process extreme care should be exercised to make certain the wires fall within the groove and do not jam against the bearing. As the coil and armature are being extracted, the protruding wires must be fed back into the housing in order to prevent their jamming and consequent damage. The armature coil is then out of the housing, but still attached to the armature and cannot be separated until the armature bearing 4-B-9 and armature bearing pin 15 are removed. This is accomplished by removing two screws 266 and slipping each half of the bearing off the armature bearing pin 15. The armature bearing pin is removed by loosening one setscrew 272 and driving the pin out of the armature.

e. Put the new coil assembly in place by inserting the lead wires through the hole and pulling on them as the coil is inserted into its support. Keep the coils in such a position that the point where the lead wires come out from the coil and the groove in the armature bearing is kept in line with the hole in the housing through which the lead wires are drawn.

f. The parts are now assembled in the reverse order from which they were disassembled. Take care that the wires of the coils are connected to their proper terminals according to the colors, as shown on the schematic diagram, figure 55. Connect the red wire of the coil nearest the contacts to the W terminals, the red wire of the coil furthest from the contacts to the Y terminal, etc.

g. In case the armature coil furthest from the contacts is to be replaced, the coil housing is left attached to the base plate 87, and the coil is removed as follows: Unsolder the lead wires from terminals 104, at points W and Y. Remove the following:

1 screw 276
1 wire clamp 83

h. Slip the spaghetti from the necessary wires and remove the top bracket 2 by taking out screw 259 and lifting the bracket carefully so that the coil retaining springs 35 are not damaged or lost. Remove the following:

1 screw 264, rear field coil
1 washer 27, rear field coil
1 pole shoe assembly 2-B-G, rear field coil

i. Remove the coil by pulling it out of the bracket and feeding its lead wires back into the hole from which they extend.

61. REPLACING FIELD COILS ON THE LINK CIRCUIT RELAY

a. When removing the field coil nearest the contacts, detach the entire coil bracket from base plate 87. Unsolder the lead wires from terminals 104 at points Y, Z, and W. Remove the following:

1 screw 276
1 wire clamp 83
2 screws 267
1 spring block 30
1 spring 42
2 screws 263
1 nut and washer from top of center isolantite insulator

Remove the housing from the base plate 87 and slip the spaghetti from the wires of the coil.

b. Provided sufficient clearance exists between the insulator clamp of the armature 2-B-J and the pole shoe assembly 2-B-G, the latter may be removed by taking out screw 264 and washer 27. However, in the event of obstruction, loosen the two screws 259 and swing the top bracket aside to provide the necessary clearance.

c. The field coil furthest from the contacts is removed by unsoldering the lead wire from the terminal 104 at point Z, and the series connection between the field coils. Wire clamp 83 is released by removing screw 276, and the spaghetti slipped off the wires. Screw 264 and washer 27 are removed, which permits the withdrawal of the pole piece assembly and coil.

d. The coil may be removed, another one substituted in its place, and the relay reassembled by reversing the sequence followed in disassembly. Take care that the wires from the coils are properly connected. Connect the red wire of the coil nearest the contacts to the W terminal and the red wire of the coil furthest from the contacts to the Z terminal. The two black wires are to be connected together, the joint insulated and clamped together with the other coil leads.

62. FUSES, PILOT LAMPS, AND AIR FILTER

a. All pilot lamps may be replaced by prying off the glass jewel from the front. The pilot lamps on the transmitter are of the screw-in type and those on the remote control unit are of the telephone switchboard plug-in type.

b. The power fuses on the transmitter are standard cartridge fuses, located on the board visible through the lower panel of the left door. The d-c meter fuse F13 is mounted on back of the D.C. METER. The line fuse F1R, on the remote control unit, is mounted in an extractor post on the rear chassis apron.

c. Every 256 hours remove air filter as indicated in subparagraph 64a. Clean the filter by tapping out the dust. When too much dust and dirt remain in the filter, replace it.

63. TROUBLE LOCATION AND REMEDY CHART

This chart lists some possible troubles and remedies. However, no such chart can ever be complete and there is no substitute for an understanding of the transmitter circuits on the part of the service man. In working on this equipment, remember that VOLTAGES DANGEROUS TO LIFE ARE EXPOSED WHEN SIDE OR REAR SHIELDS ARE REMOVED. Attempt to diagnose the trouble and then make checks or changes with the MAIN POWER SWITCH OFF. If it is necessary to make measurements inside the transmitter with the PLATE switch ON, proceed with utmost care. Do not rely on the red plate pilot as an indication of absence of plate voltage, since the bulb may burn out. A knowledge of circuit functioning and the visual indications provided by the meters and pilot lights enable the maintenance man to narrow down the trouble to a particular stage. This stage may then be checked by tube substitution and resistance and voltage measurements. If the main plate rectifier fuses are blown, the bulb will go out, although the auxiliary plate rectifier may be still on. Where the following instructions recommend shorting a protective device, it is intended only as a temporary measure to trace the trouble. Do not attempt permanent operation with any protective device out of the circuit.

AS AN AID IN TROUBLE SHOOTING AND PART LOCATION, REFERENCE MAY BE MADE TO THE FOLLOWING FIGURES:

Radio Transmitter BC-446-J

Fig.
65 Rear and right side view, shield removed.
66 Rear and left side view, shield removed.
35 Schematic diagram.
67 Interconnecting cable diagram.

Remote Control Unit RM-45-A

68 Top view, cover removed.
69 Bottom view, cover removed.
70 Tube and capacitor layout diagram.
48 Schematic diagram.
71 Wiring diagram.
72 Microphone T-32, wiring diagram.

R-f chassis

73 Top view.
74 Schematic diagram.
75 Tube socket layout diagram.
76 Wiring diagram.

A-f chassis

77 Top view, tubes removed.
78 Top and front view.
79 Schematic diagram.
80 Tube socket layout diagram.
81 Wiring diagram.

Goniometer

Fig.
82 Front panel.
83 Rear and right side view.
84 Disassembled.
85 Left tuning unit, front and side view.
86 Left tuning unit, side view.
87 Right tuning unit, front and side view.
88 Right tuning unit, side view.

Main plate rectifier chassis

89 Front and side view.
90 Schematic diagram.
91 Tube socket layout diagram.
92 Wiring diagram.

Auxiliary plate rectifier chassis

93 Front and side view.
94 Schematic diagram.
95 Tube socket layout diagram.
96 Wiring diagram.

Relay and bias rectifier chassis

97 Top and side view.
98 Schematic diagram.
99 Wiring diagram.

Bias voltage regulator tube chassis

100 Front and side view.
101 Schematic diagram.
102 Tube socket layout diagram.
103 Wiring diagram.

R-f current meter rectifiers

Fig.
104 Link circuit, outside and inside views.
105 Left meter rectifier, outside and inside views.
106 Right meter rectifier, outside and inside views.
107 Schematic diagram.
108 Tube socket layout diagram.
109 Wiring diagram.

Meter and control unit

110 Rear and right side view.
111 Rear view.
112 Top and left side view.
113 Bottom and right side view.
114 Schematic diagram.
115 Wiring diagram.

Miscellaneous figures

116 Quarter-phasing relay.
117 Tube and capacitor base pin connections.
118 R.M.A. resistor and capacitor color code charts.
54 Keying circuits, simplified functional diagram.

63. TROUBLE LOCATION AND REMEDY CHART (cont'd)

Possible Cause	*Check and Remedy*
a. Transmitter will not turn on by remote control. Green pilot on remote control unit does not light.	
1. Defective pilot P3R. 2. Defective tube V1R. 3. Defective reactor X1R. 4. Defective switch S2R. 5. Open resister R5R. 6. Open control line. 7. Defective relay E9.	Try a new pilot lamp. If no results occur, check for voltage between terminals 5 and 3 on the remote control unit with terminal 5 disconnected. If no voltage occurs, try a new tube V1R. If still no voltage occurs, check for continuity between the plate pins of the rectifier tube and terminal 5. If voltage exists between terminals 5 and 3, check for open telephone line. If the lines are all right, try a continuity check on the coil of E9.
b. Transmitter will not turn on by remote control. Green pilot on remote control unit lights.	
1. Shorted or grounded control lines. 2. Defective relay E9.	Disconnect the line to terminal 5 on the transmitter. If there is no voltage on this line, the control lines are shorted or grounded. If voltage exists on this line the trouble is with relay E9. Try a resistance check on the coil. Clean the contacts if everything else appears to be normal.
c. Transmitter will not switch to voice. Red pilot on remote control unit does not light.	
1. Defective pilot P2R. 2. Defective relay E1R. 3. Open control line. 4. Defective relay E7. 5. Defective microphone switch.	Try a new pilot lamp. If no results occur, check for voltage between terminals 4 and 3 on the remote control unit with the line disconnected from terminal 4 and the PRESS TO TALK tab down. If no voltage occurs, check to see if relay E1R operates when the PRESS TO TALK tab is pressed. If it does not operate, the coil is probably open. Check the contacts. If still no results occur, the microphone switch may be defective. If approximately 35 volts is found between terminals 4 and 3, check for an open control line. If the line appears to be all right, try a continuity check on the coil of relay E7.
d. Transmitter will not switch to voice. Red pilot on remote control unit lights.	
1. Shorted or grounded control lines. 2. Defective relay E9. 3. Defective relay E11.	Tie the PRESS TO TALK tab down. Disconnect the line to terminal 4 on the transmitter. If there is no voltage on this line, the control lines are shorted or grounded. If voltage exists on this line, check the operation of E9. Try a resistance check on the coil. Clean the contacts. If everything appears normal with relay E9, try a resistance check on the coil of E11.
e. Transmitter will not turn on by either local or remote control. Relay E4 will not close.	
1. Defective relay E4. 2. Defective thermostat TH4.	Check the primary power into the transmitter. Check fuses F1 and F2. Check TH4. It should open only at a dangerously high temperature. If no results occur, check the coil of E4.
f. Transmitter switches over to voice, but voice signals do not get through.	
1. Defective microphone. 2. Defective control resistor R2R. 3. Defective transformer T2R. 4. Shorted or grounded audio line. 5. Defective transformer T12. 6. Defective control resistor R29. 7. Defective relay E10.	If the AUDIO LINE LEVEL meter on the remote control unit does not read, disconnect the audio line from terminals 1 and 2. If the meter still does not read, try resistance checks from terminals 1 to 3, and 2 to 3. If still no results occur, disconnect the microphone and check the MODULATION control and the primary of transformer T2R. The microphone switch may be defective. If the AUDIO LINE LEVEL meter reads after the audio line has been disconnected, the line is probably shorted or grounded. Check by disconnecting the audio line at both the remote control unit and the transmitter, and measure the resistance between the lines and between each line and ground. It should be infinite in each case. If there are still no results, try a resistance check between terminals 1 and 2 on the transmitter and the chassis. Clean the contacts of E10.
g. Relay E4 closes, but the green pilot does not light. There is no filament voltage.	
1. Defective fuses. 2. Defective voltage stabilizer VR1.	Check fuses F7 and F8. If these are all right, try operating with switch S4 in the OUT position. If normal operation is obtained in this position, the voltage stabilizer VR1 is defective. If the primary power frequency drops to 50 cycles even for a short time, fuses F7 and F8 will blow. If this trouble is recurrent, operate with S4 out.

63. TROUBLE LOCATION AND REMEDY CHART (cont'd)

Possible Cause	*Check and Remedy*
h. Filaments operate normally but neither plate rectifier operates with PLATE switch ON.	
1. Defective relay E5. 2. Defective relay E6. 3. Defective thermostat TH3. 4. Open switch S10, S11.	Operate PLATE switch to OFF, open the right door, close the interlocking switch, and note whether E6 closes approximately 30 seconds after E4. If it does not, check the action of E5. If this appears normal, check the door interlock switches S10 and S11. TH3 should be closed. At low temperatures TH3 will remain open until the tube heaters have raised the temperature of the mercury vapor rectifiers to a safe value. If TH3 does not close in 10 minutes, check the tube heaters. If E6 closes, check fuses F5, F6, F11 and F12.
i. PLATE switch will not stay in ON position.	
1. Short in main plate rectifier. 2. Antenna detuning. 3. Defective tubes V3, V4, V5 or V6.	If the PLATE switch will not stay on, push it all the way down and then push it up. If it will still not stay on, there is an overload on the main plate rectifier. Set the TONE GAIN to zero and the OUTPUT COUPLING to zero. If the PLATE switch will now stay on, the trouble is probably detuning of the antenna. If decoupling does not help, try removing the plate caps on the p-a tubes. Do not let the caps touch the chassis. If the plate will now stay on, check the p-a stage for detuning or an actual short. If none of these expedients help, look for a short in the main plate rectifier.
j. Red pilot lights. Main plate rectifier operates. Auxiliary plate rectifier does not operate.	
1. Defective fuses F5, and F6. 2. Defective tube V10 or V11. 3. Defective transformer T4.	Check fuses F5 and F6. If fuses are all right, replace V10 and V11. If this does not help, check for filament voltage on V10 and V11. If F5 and F6 blow after replacement, look for a short in the rectifier output. If no short is found, replace all the JAN-807 tubes and try the old tubes one at a time in the V9 socket. A defective tube will not oscillate but cannot blow the fuse in this socket.
k. The crystal does not start reliably.	
1. Defective crystal. 2. Improper tuning.	Increase the reading of the CRYSTAL TUNING dial so that the CRYSTAL OSC. current increases 3 ma. If this does not help, try another crystal. Check the crystal clips for good contact pressure.
l. P.A. PLATE current is abnormal. LINK CURR. is very high.	
1. Detuning.	Check the tuning of the antenna. The transmission lines may be shorted or grounded.
m. The identification keying is garbled.	
1. Defective tube V2 or V9. 2. Defective identification switch contacts.	Place headphones across the primary of T7. If the keying is clear, replace the intermediate p-a tube V2. If the keying is still garbled, try a new tube in the V9 socket. If keying is still garbled, check the identification switch contacts on the keyer.
n. Carrier output is normal. No tone output. A.C. METER cannot be made to read 115 volts when on MOD. position.	
1. Defective transformer T9. 2. Defective transformer T7. 3. Defective tubes. 4. Defective transformer T8. 5. Defective relay E10.	Try a new tube in the V9 socket. If no results occur, remove fuses F11 and F12, and check for audio on the grids of V5 and V6, using headphones. If audio is present, replace F11 and F12 and try new tubes for V5 and V6. If still no results occur, transformer T9 is open or shorted. If no audio is present on the grids of V5 and V6, check for audio on the grids of V7 and V8. If present, try replacing V7 and V8. If not present, check the back contacts on E10.
o. Transmitter operates normally but one of the r-f currents does not read.	
Defective meter rectifier tube	Replace the tube in the current metering unit which does not read.
p. Output voltage from plate rectifier is about half under normal load.	
Defective rectifier tube.	Try replacing the rectifier tubes one at a time until the trouble is located.
q. CRYSTAL OSC. current reads low. Other tube currents appear normal.	
1. Defective tube V1. 2. Resistors R1 or R2 open.	Try a new tube in the V1 socket. If no results occur, make a resistance check from the tube socket to ground.
r. CRYSTAL OSC. current reads high. Other tube currents appear normal.	
Defective tube V1.	Try a new tube in the V1 socket.

63. TROUBLE LOCATION AND REMEDY CHART (cont'd)

Possible Cause	*Check and Remedy*
s. Intermediate p-a current reads low or zero.	
1. Defect in power supply. 2. Shorted or leaky capacitors. 3. Defective tube. 4. Open resistor R3.	Check the auxiliary plate rectifier voltage. If this voltage is low, look for a high resistance short in the auxiliary plate supply circuits. Trouble would be most likely a leaky bypass capacitor. If the auxiliary plate rectifier voltage is normal, try a new tube in V2 socket. If this gives no results, make a resistance check from the tube socket to ground.
t. Intermediate p-a current reads high.	
1. Defect in power supply. 2. Defective tube. 3. Shorted capacitors C4, or C8.	Check the tuning. Check the auxiliary plate voltage. If this is high, the power supply bleeder is probably open. If the auxiliary plate voltage is normal, try a new tube in the V2 socket. If this does not correct the trouble, make a resistance check from the tube socket to ground.
u. P-a current is not normal. Other tube currents appear normal.	
1. Defective tubes. 2. Defective bypass capacitors. 3. Open or shorted grid circuit.	Try a new tube in the V3 and V4 tube sockets. If this does not correct the trouble, make a resistance check from the tube socket to ground.

64. REMOVAL AND ASSEMBLY OF PARTS

a. Air Filter. The air filter at the rear of the transmitter fits into a holder at the rear of the blower housing. To remove, take off the rear bottom shield of the transmitter. The air filter at the top of the transmitter is held in place by brackets on all sides. To remove, take off either one of the side brackets. The brackets are fastened by machine screws which fit into tapped holes in the panel.

b. Blower. The blower B1 is located behind the air filter at the rear of the transmitter. To remove, take off the rear bottom shield and the air filter. Disconnect the four leads which are attached to the terminal board on the blower housing. Remove the fan blade assembly by turning the small setscrew which anchors it to the motor shaft. Release the motor from its mounting frame by turning the four setscrews at the top of the motor.

c. Relays. (1) Relays E7 and E9 are mounted on the fuse and relay panel at the lower left of the transmitter and are accessible through the left door. The electrical connections to these relays are made from the front of the panel. To remove either of these relays, unfasten the four connecting strips and take out the two Phillips head screws on the base of the relay. These screws fit into tapped holes on the fuse and relay panel.

(2) Relays E4 and E6 are mounted on the relay panel at the lower right and are accessible through the right door. The electrical connections to these relays are made through the mounting studs. To remove either of these relays, take off the six nuts on the base.

(3) Relay E5 is mounted on the relay panel at the lower right. Its mounting is similar to that of relays E4 and E6 except that there are four studs instead of six.

d. Voltage Regulator Cut-Out Switch S4. The voltage regulator cut-out switch S4 is mounted on the relay panel at the lower right. The right bottom side shield of the transmitter must be removed to provide access to the electrical connections on this switch.

e. Voltage Stabilizer VR1, Transformer T1, and Filter Choke X4. These items are mounted on the bottom shelf. Each of these units is fastened by a bolt on each of the four corners To reach the nuts associated with these bolts it is necessary to remove one of the narrow metal skirts at the base of the transmitter.

f. Keyer. The keyer E1 is mounted on the second shelf and is visible through the right door. The unit is mounted on a metal panel. To remove the keyer, take off the right bottom side shield of the transmitter. Disconnect the leads to the terminal block at the rear of the metal panel. The panel is held in place by five bolts, three at the top and two at the bottom. After these bolts have been removed, the entire unit can be pulled out.

g. Bias and Relay Rectifier Unit. The bias and relay rectifier unit is mounted directly in back of the keyer. To remove this unit, take off the bottom right side shield of the transmitter. The unit has two terminal strips mounted on it. Disconnect the wires from each terminal strip and also the wires on the keyer terminal block. The unit is fastened to the frame of the transmitter with six bolts.

h. Voltage Regulator Tube Chassis. The voltage regular tube chassis is mounted on the second shelf at the left of the transmitter and is visible through the left door. To remove this unit, disconnect the two wires at the bottom of the resistor mounting board and take out the four screws which hold the chassis in place.

i. Auxiliary Plate Rectifier Chassis. The auxiliary plate rectifier chassis is mounted on the second shelf directly in back of the voltage regulator tube chassis. To remove this unit, take off the left bottom shield of the transmitter. Remove the voltage regulator tube chassis. Disconnect all wires on the auxiliary plate rectifier terminal board. The chassis is fastened to the transmitter frame by three bolts on each end. It may be necessary to remove the right bottom shield of the transmitter to provide access to the three bolts on the far end of the chassis.

j. Main Plate Rectifier Chassis. The main plate rectifier chassis is mounted directly behind the auxiliary plate rectifier chassis. To remove this unit, take off the left bottom shield of the transmitter. Disconnect the wires on the rectifier terminal board. Remove three bolts on each end of the rectifier chassis. To provide access to the bolts on the far end of the chassis, take off the right bottom shield of the transmitter.

k. Transformers T4 and T10. Transformers T4 and T10 are mounted on the second shelf at the rear of the transmitter. They are bolted at each corner to the transmitter frame. To remove either one of these transformers, take off the bottom shields at the left side and rear of the transmitter. If the operator's hands are large, he may not be able to reach the nuts because the clearance between the blower housing and the transformers is only about 2 inches. In such case, remove the metal skirt at the rear of the transmitter. Remove the blower and housing by taking out seven screws at the base of the housing. This will provide ample clearance to remove the transformers.

l. A-F Unit. The a-f unit is mounted on the third shelf and is visible through the left door. To remove this unit, take off the bottom shields at the left side and rear of the transmitter. Disconnect all wires from the a-f unit to the meter and control unit at the terminal board on the side of the meter and control unit. Disconnect all wires from the outside to the terminal block at the rear of the unit. Disconnect the wires to terminals 4 and 5 of transformer T9. Disconnect two wires to the voice input terminal board at the front of the unit. Remove the seven bolts which hold the chassis to the transmitter frame.

m. R-F Unit. The r-f unit is mounted on the third shelf and is visible through the right door. To remove this unit, take off the bottom shields at the right side and rear of the transmitter. Disconnect all leads to the terminal board at the rear of the chassis. Disconnect wire 16 to coil X3, and the five bus-bar leads to the meter and control unit. Remove the bar that couples the crystal switch S1 to the control knob on the front panel. The chassis is bolted to the transmitter frame at the front and rear.

n. Meter and Control Unit. The meter and control unit occupies the center of the third shelf. To remove this unit, take off all the bottom shields of the transmitter. Disconnect all wires to the terminal boards at the left side and rear of the unit. Disconnect the two wires to the feed-through insulator near the center at the back of the unit. Remove the ground connection from inductor L15. Remove the ground wire at the front of the unit. Disconnect the five bus leads at the right side of the unit. Remove the crystal switch connecting bar. Unscrew the two adjusting nuts at the rear corners of the unit. Remove the three bolts on either side of the front of the unit which fasten it to the transmitter frame. Remove the three bolts at top and bottom of the front panel. Lift the unit off the adjusting studs at the rear and slide forward.

o. Items on Switch Panel. Local-remote switch S2, filament switch S3, main power switch E3, plate switch E8, and keyer switch S5 are all mounted on the switch panel at the front of the transmitter. When replacing any one of these switches it is best to remove all screws on this panel and tilt it forward. This will provide access to the rear of the switches.

p. Pilot Bulbs. The pilot bulbs are of the screw base type. The caps can be pried off. A small piece of rubber or tape will be helpful in providing a grip when removing the bulbs.

q. Link Circuit Relay E2. The link circuit relay E2 is located on the left side and is visible through the left door. To remove, take off the left bottom shield of the transmitter. Disconnect the three wires at the bottom of the relay and loosen the two clamps which hold this cable in place. Disconnect the three bus leads at the top of the relay. The relay is held in place by two bolts.

r. L Pad. The L pad is directly behind the link circuit relay and is fastened at the top to the left

primary tuning compartment. The mounting bolts can be identified by the four square nuts at the bottom of the tuning compartment. In removing this unit, take off both left side and rear bottom shields of the transmitter. Disconnect the two heavy wire leads and three bus leads at the back of the insertion link mounting board. Unsolder the wire lead to resistor R52 and loosen the cable clamps which hold this wire in place. Remove the four square nuts in the bottom of the tuning compartment.

s. Goniometer Tuning Compartments. (1) The left goniometer tuning compartment is mounted on the top shelf. To remove this unit, take off both left side shields of the transmitter. Remove the L pad as outlined in the foregoing subparagraph **r**. Remove the ground wire at the outside of the unit which connects to the transmitter frame. At the rear of the unit, and next to the goniometer compartment, remove coil L16, the heavy wire lead to the goniometer and the ground connection. At the inside top of the unit remove the coil L10. Disconnect the bus leads to the goniometer, the left secondary current meter rectifier unit, and the antenna entrance cup insulator. The unit is fastened to the frame of the transmitter by a bolt in each of the four bottom corners and by seven machine screws in the front panel. Remove these and slide the unit forward.

(2) The right goniometer tuning compartment is mounted on the top shelf. To remove this unit, take off both right side and rear shields of the transmitter. Remove the ground wire at the outside of the unit which connects to the transmitter frame. At the rear of the unit and next to the goniometer compartment remove coil L17, the heavy wire lead to the goniometer, and the ground connection. At the inside top of the unit remove coil L11. Disconnect the bus leads to the goniometer, the right secondary current meter rectifier unit, and the antenna entrance cup insulator. The unit is fastened to the frame of the transmitter by a bolt in each of the four bottom corners and by seven machine screws in the front panel. Remove these and slide the unit forward.

t. Goniometer. The goniometer occupies the center of the top shelf. The goniometer itself is entirely surrounded by a copper shield. To remove this unit, take off both rear shields and the top shield of the transmitter. Remove the L pad and the right and left tuning compartments as previously described. Remove the ground lead at the front of the unit. At the rear of the goniometer compartment, disconnect coils L16 and L17 and the outside wires to the ground stud located at the bottom center. At the top of the compartment, disconnect the two bus-bar leads to each of the tuning compartments and the leads to the antenna ground studs. Each meter rectifier has a terminal strip to which three wires are attached. Disconnect these wires and unfasten the cable from its clamps as far back as the top of the transmitter. The rear of the goniometer compartment is held in place by two mounting brackets. Remove the bolts which hold these brackets to the transmitter frame. The goniometer front panel is fastened to the frame by six screws. Three of these are under the hatch cover. Remove all six and pull the unit forward.

u. Goniometer Primary and Secondary Tuning Gear Assemblies. To remove the primary and secondary tuning gear assemblies, loosen the Allen head setscrews at the front and rear of the rigid shaft coupling. Slide the coupling forward. Turn the setscrew in the dial knob and remove the knob and dial lock actuator. Take out the four Phillips head screws immediately under the shaft. The gear assembly is now free and can be removed.

v. Shaft Couplings. The rigid couplings and tubular shaft couplings should be removed by following the procedure for the tuning gear assemblies. Slip the coupling from the shaft after the gear assembly has been removed.

w. Inductors. Inductor L7 is fastened to the chassis by three lugs. Remove these lugs with the coil. To remove inductors L3 and L4, uncouple the extension shaft at the front end by turning the setscrews in the shaft coupling and sliding the coupling back. Remove the coil by taking out the four screws which hold the coil support to the metal panel. After the coil has been removed, the taper pin which couples the shaft to the coil can be knocked out.

65. REPLACEMENT OF RELAY CONTACTS

a. On relays E4 and E6, remove the fixed contacts by loosening the locknut at the base of the contact. Remove the movable contacts by taking out the two cotter pins, washers, and springs holding each movable arm in place. The end of the flexible lead is riveted in place. Remove this lead by heating the joint with a soldering iron and bending the clamps back. The replacements do not need to be riveted in place as contact will be

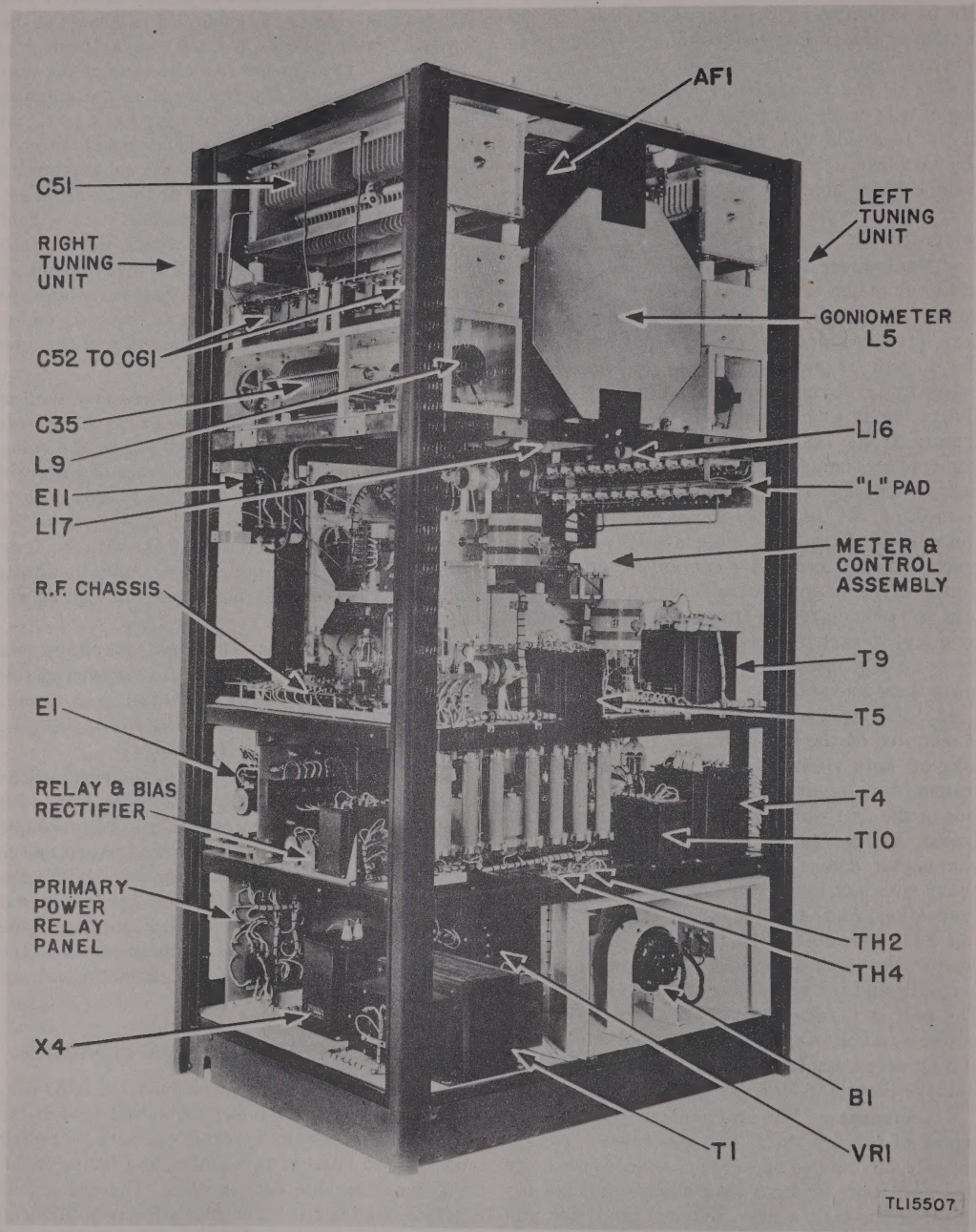


Figure 65. Radio Transmitter BC-446-J, rear and right side view, shield removed.

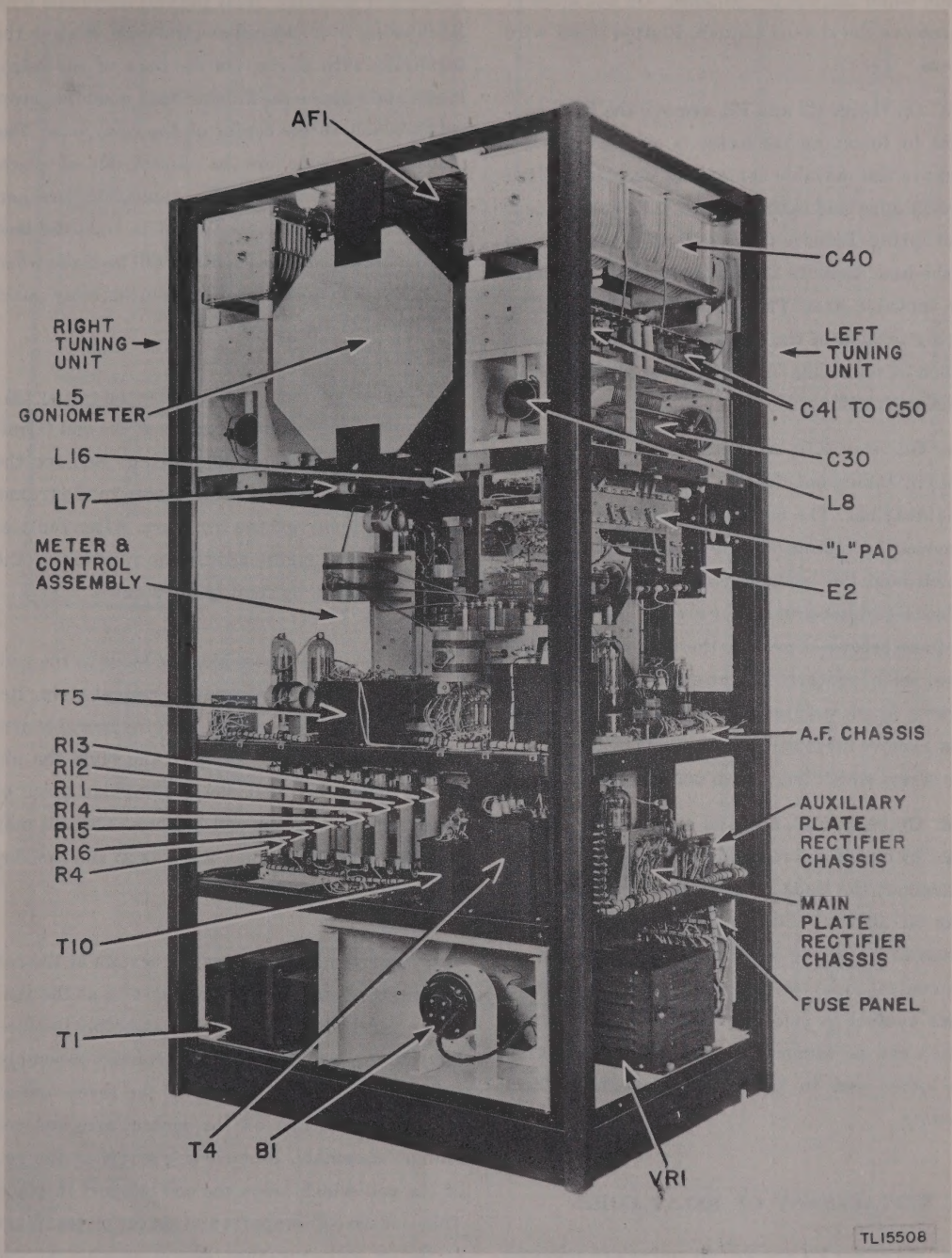


Figure 66. Radio Transmitter BC-446-J, rear and left side view, shield removed.

made when the nut is tightened. Do not attempt to remove the riveted contact. Flatten it out with pliers.

b. On relays E7 and E9, remove the fixed contacts by loosening the locknuts on each contact. Remove the movable contact by unsoldering the flexible wire lead to the contact. Uncouple the tension spring. Remove the two Phillips head screws in the base. Remove the drive pin which supports the movable arm. This pin is held in place by spring tension of the movable arm. Do not use a punch in removing. The pin can be pushed out of place with stiff wire.

c. On relay E10, remove the upper fixed contacts by taking out the two screws on the contact mounting bar. The movable contacts can then be removed by taking out the two machine screws which hold the movable contact terminal strip. A brace and bakelite spacer are also held in place by these screws. Unsolder the flexible wire leads from each contact. Remove the two machine screws which hold each contact in place. After this, remove the lower fixed contacts by taking out the screw which holds each contact in place.

d. On relay E11, all fixed contacts are held in place by machine screws and locknuts. To remove, disconnect the leads at the back of the panel and take off all nuts. The movable contacts may be removed by taking off the nuts on each end of the contact mounting bar and removing the bar. Each contact is held in place by a collet screw which can be removed. Insert a screwdriver on the other end to prevent the assembly from turning.

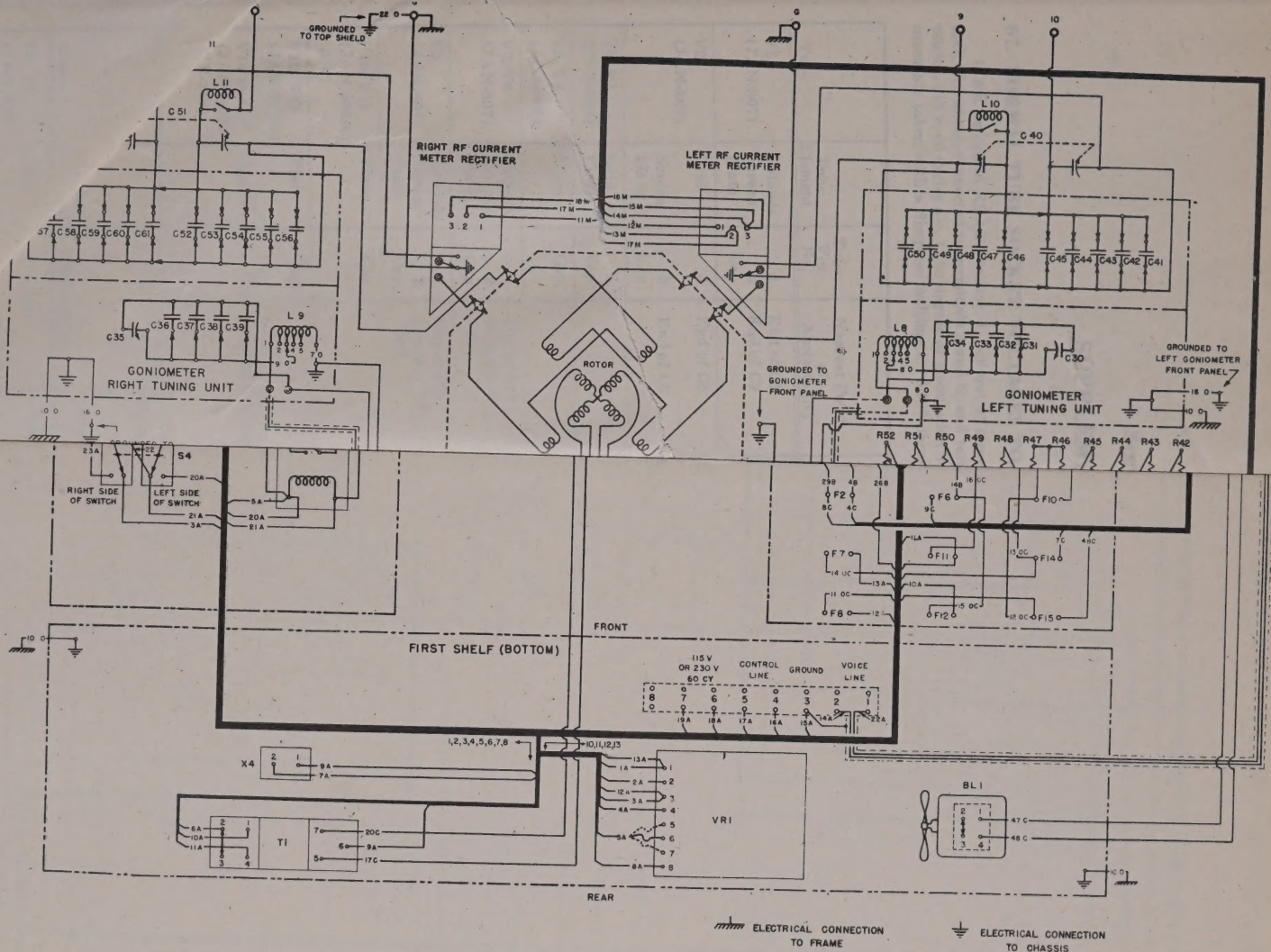
66. REPLACEMENT OF RELAY COILS

a. On relays E4 and E6, the coil can be removed by first removing the relay from the panel upon which it is mounted. Heat the coil terminals with a soldering iron and remove the wire. Flatten the terminals with pliers. On the back of the relay, locate and remove the fillister head machine screw set in a hole in the center of the relay base. The coil and core can now be slipped out of place. Remove the core and the nameplate bracket. When replacing, do not attempt to rivet the new coil terminals in place. Contact will be made when the relay is mounted properly on the relay panel and the nuts tightened.

b. On relays E7 and E9, remove the coil by taking out the Phillips head screws at the coil terminals. Uncouple the tension spring. Remove the two screws which hold the iron core to the frame. The coil will slip off the iron core. After replacement has been made, adjust the position of the iron core before tightening the screws.

c. On relay E10, unsolder the leads to the coil. Remove the movable contact terminal strip. Remove the two screws which hold the movable arm support. Take off the support and slide the pin out of place. Lift out the rectangular piece of metal which holds the coil in place. The coil may have to be heated to melt the wax at the base before it can be removed.

d. On relay E11, remove the screws at the coil terminals. Take out the three screws at the rear of the panel which hold the coil assembly in place. Lift off the coil and movable contact assembly. Remove the nuts at the end of the three-contact mounting arm. Lift off the contact arm and coil plunger assembly. Remove one screw at the end of the coil which holds the coil support in place. Take out the coil supports and spacer plates. When replacing, make sure that the coil leads are pointed toward the base of the relay.



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7. Radio Transmitter BC-446-J, interconnecting cable diagram.

made when the nut is tightened. Do not attempt to remove the riveted contact. Flatten it out with pliers.

b. On relays E7 and E9, remove the fixed contacts by loosening the locknuts on each contact. Remove the movable contact by unsoldering the flexible wire lead to the contact. Uncouple the tension spring. Remove the two Phillips head screws in the base. Remove the drive pin which supports the movable arm. This pin is held in place by spring tension of the movable arm. Do not use a punch in removing. The pin can be pushed out of place with stiff wire.

c. On relay E10, remove the upper fixed contacts by taking out the two screws on the contact mounting bar. The movable contacts can then be removed by taking out the two machine screws which hold the movable contact terminal strip. A brace and bakelite spacer are also held in place by these screws. Unsolder the flexible wire leads from each contact. Remove the two machine screws which hold each contact in place. After this, remove the lower fixed contacts by taking out the screw which holds each contact in place.

d. On relay E11, all fixed contacts are held in place by machine screws and locknuts. To remove, disconnect the leads at the back of the panel and take off all nuts. The movable contacts may be removed by taking off the nuts on each end of the contact mounting bar and removing the bar. Each contact is held in place by a collet screw which can be removed. Insert a screwdriver on the other end to prevent the assembly from turning.

66. REPLACEMENT OF RELAY COILS

a. On relays E4 and E6, the coil can be removed by first removing the relay from the panel upon which it is mounted. Heat the coil terminals with a soldering iron and remove the wire. Flatten the terminals with pliers. On the back of the relay, locate and remove the fillister head machine screw set in a hole in the center of the relay base. The coil and core can now be slipped out of place. Remove the core and the nameplate bracket. When replacing, do not attempt to rivet the new coil terminals in place. Contact will be made when the relay is mounted properly on the relay panel and the nuts tightened.

b. On relays E7 and E9, remove the coil by taking out the Phillips head screws at the coil terminals. Uncouple the tension spring. Remove the two screws which hold the iron core to the frame. The coil will slip off the iron core. After replacement has been made, adjust the position of the iron core before tightening the screws.

c. On relay E10, unsolder the leads to the coil. Remove the movable contact terminal strip. Remove the two screws which hold the movable arm support. Take off the support and slide the pin out of place. Lift out the rectangular piece of metal which holds the coil in place. The coil may have to be heated to melt the wax at the base before it can be removed.

d. On relay E11, remove the screws at the coil terminals. Take out the three screws at the rear of the panel which hold the coil assembly in place. Lift off the coil and movable contact assembly. Remove the nuts at the end of the three-contact mounting arm. Lift off the contact arm and coil plunger assembly. Remove one screw at the end of the coil which holds the coil support in place. Take out the coil supports and spacer plates. When replacing, make sure that the coil leads are pointed toward the base of the relay.

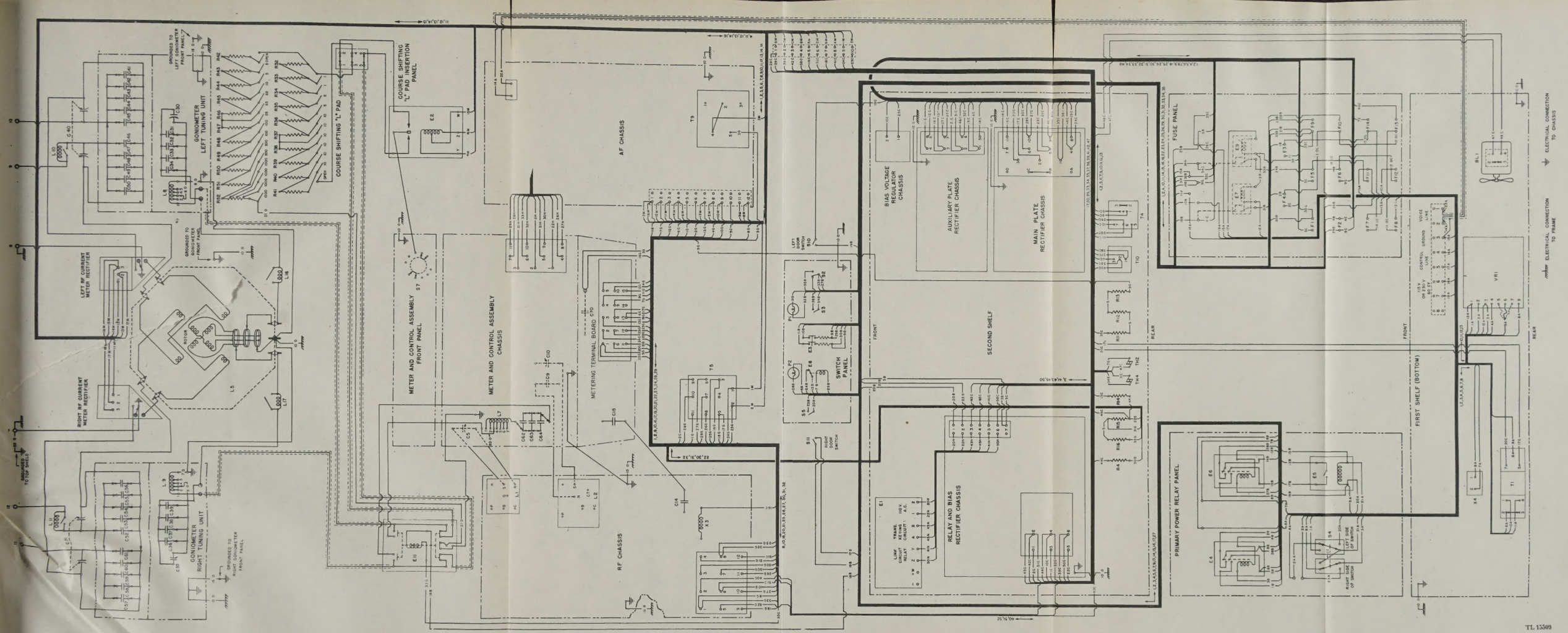

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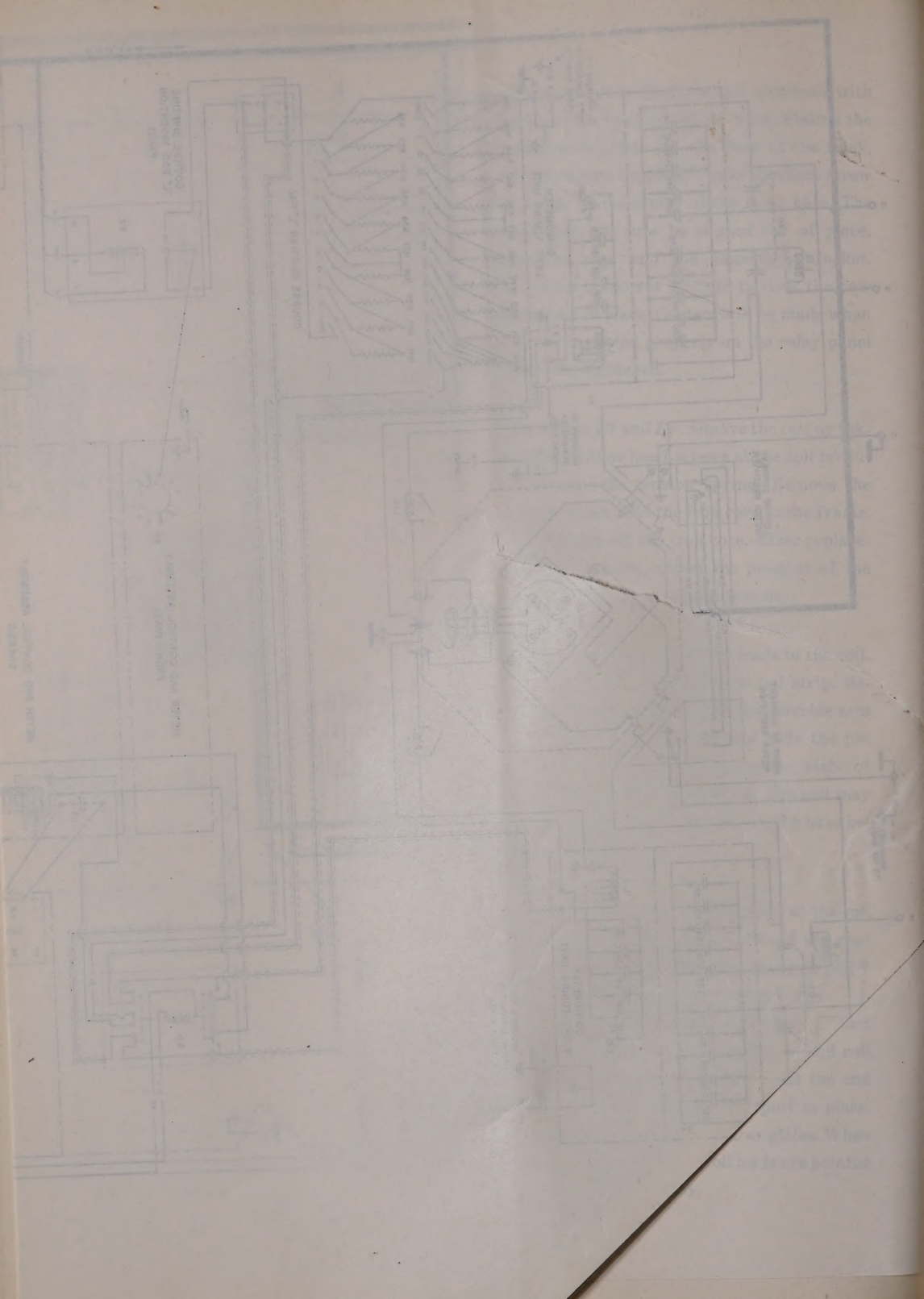
Figure 67. Radio Transmitter BC-446-J, interconnecting cable diagram.



Section V

SUPPLEMENTARY DATA

67. NORMAL TUBE SOCKET VOLTAGES TO GROUND (Radio Transmitter BC-446-J)

LINK switch in READ position. L pad out of circuit. Goniometer set at 135°. Non-inductive dummy load resistors, each 35.5 ohms, connected to terminals 9 and G, and terminals 12 and G. Transmitter set up for tower operation. Power source, 115 v, 60 cycles a-c. (The degree of modulation does not appreciably affect the d-c tube socket voltages.) All measurements taken with a Simpson multimeter, 5,000 ohms per volt d-c, 1,000 ohms per volt a-c.

Tube	Tube Element	Tube Pin No.	Nearest Point of Accessibility	Scale v	Transmitter Operating — Tone Gain Zero					
					C5 Grossly Detuned		Completely Tuned			
					Ident. Key Closed		Ident. Key Closed		Ident. Key Open	
					a-c v	d-c v	a-c v	d-c v	a-c v	d-c v
V1 (JAN-807)	Cathode	4	End of C1	50		12		5		5
	Screen	2	End of C2	250		155		150		160
	Plate	Cap		250		225		230		270
V2 (JAN-807)	Grid	3	End of C3	250		−60		−225 to −250		−260
	Screen	2	End of C6	250		235		200		−50
	Plate	Cap		1000		500		500		520
V3, V4 (JAN-805)	Grid	G		250		−80		−175		−150
	Plate	Cap		5000		1200		1100		1200
V5, V6 (JAN-805)	Plate	Cap		5000		1200		1130		1200
V7, V8 (JAN-807)	Cathode	4	End of R17	50		16.5		16.5		19
	Screen	2	Junction R14,	1000		235		235		260
	Plate	Cap	R15	1000		500		480		500
V9 (JAN-807)	Cathode	4	End of C26	25		19		19		0
	Screen	2	Junction R26,	250		106		106		−25
	Plate	Cap	R27	1000		400		400		500
V10, V11 (JAN-866A/ 866)	Plate	Cap		1000	590		590		600	
V12, V13 (JAN-872A)	Plate	Cap		5000	1600		1570		1600	
V14 to V17 (JAN-0D3/ VR-150)	Cathode	2	Junction R3, R30	250		−85		−155		−150

Tube	Tube Element	Tube Pin No.	Transmitter Operating — Completely Tuned 0.1 μf — 2000 Volt Capacitor in Series With High Side of Meter Used Ident. Key Closed					
				Mod. Level at 100 v			Mod. Level at 30 v	
			Scale v	500 cps a-c v	1020 cps a-c v	Scale v	500 cps a-c v	1020 cps a-c v
V5, V6 (JAN-805)	Plate	Cap	1000	520	520	250	150	150
V7, V8 (JAN-807)	Plate	Cap	250	125	130	50	31	31

68. NORMAL POINT TO POINT VOLTAGES AND VOLTAGES TO GROUND (Radio Transmitter BC-446-J)

LINK switch in READ position. L pad out of circuit. Goniometer set at 135°. Non-inductive dummy load resistors, each 35.5 ohms, connected to terminals 9 and G, and terminals 12 and G. Transmitter set up for tower operation. Power source, 115 v, 60 cycles a-c. (The degree of modulation does not appreciably affect the d-c tube socket voltages.) All measurements taken with a Simpson multimeter, 5,000 ohms per volt d-c, 1,000 ohms per volt a-c.

Item	From	To	Scale v	Transmitter Operating — Tone Gain Zero					
				C5 Grossly Detuned		Completely Tuned			
				Ident. Key Closed		Ident. Key Closed		Ident. Key Open	
				a-c v	d-c v	a-c v	d-c v	a-c v	d-c v
Transformer T5	7	Gnd	2.5		0		1.05		0
Transformer T5	10	Gnd	2.5		0.67		0.65		0.67
Transformer T5	3	5	10	6.3		6.3		6.3	
Transformer T5	9	11	10	10		10		10	
Transformer T5	6	8	10	10		10		10	
Transformer T3	3	5	10	2.5		2.5		2.5	
Transformer T3	1	2	250	115		115		115	
Transformer T2	3	5	10	5.0		5.0		5.0	
Transformer T6	5	8	250	145		145		145	
Transformer T2	1	2	250	115		115		115	
Transformer T5	1	2	250	115		115		115	
Aux. Plate Rectifier	R14	Gnd	1000		520		520		540
Main Plate Rectifier	R11	Gnd	5000		1200		1180		1200
Junction R18 and C29		Gnd	250		−85		−155		−150
Across Heater H5			250	115		115		115	
E7 energized	Input 4	Gnd	2.5		−1.65		−1.65		−1.65
	Input 5	Gnd	2.5		−1.85		−1.85		−1.85
E9 energized	Input 1	Gnd	2.5	0	0	0	0	0	0
	Input 2	Gnd	2.5	0	0	0	0	0	0
Relay E2 Left Side	Y	Gnd	250		−95		−95		−95
	Z	Gnd	250		−95		−95		−95
	Y	Z	250		0		0		0
Relay E2 Right Side	Y	Gnd	250		0		0		0
	Z	Gnd	250		−125		−125		−125
	Y	Z	250		125		125		125
Across R3			250		0		95		135
Across R30			250		152		185		45
Across R19			250		157		192		45
Across R5			50		0		29		0
Across R4			50		0		21		0
Across R26			250		124		124		−25
Across R27			250		106		106		−25
Across R54			250		90		90		0
Across R14			1000		260		260		230
Across R15			250		93		93		110
Across R16			250		140		140		165
Across R11			1000		400		390		400
Across R12			1000		400		390		400
Across R13			1000		420		400		420

Item	From	To	Scale v	Transmitter Operating — Completely Tuned 0.1 μf — 2000 Volt Capacitor in Series With High Side of Meter Used Ident. Key Closed			
				Mod. Level at 100 v		Mod. Level at 30 v	
				500 cps a-c v	1020 cps a-c v	500 cps a-c v	1020 cps a-c v
Transformer T7	1	2	10	8	9.1	8	9.3
Transformer T9	4	5	1000	780	800	225	230

69. NORMAL RESISTANCES OF PARTS (Radio Transmitter BC-446-J)

Power off.

Item	Terminals	Scale Multiplier	Resistance (Ohms)
Blower B1	1 to 3	1	18
	2 to 4	1	18
Relay E2	Y to W (armature)	100	550
	Z to W (field)	100	7,000
Relay E4	Coil	1	180
Relay E5	Coil	100	500
Relay E6	Coil	1	180
Relay E7	Coil	1	43
Relay E8	Coil	1	5
Relay E9	Coil	1	47
Relay E10	Coil	1	300
Relay E11	Coil	1	55
Tube heaters H1, H2, H3, H4		1	55*
Crystal heater H5		100	2,000
Inductor L1	Primary	1	4.5
	Secondary	1	0.7
Inductor L2	Primary	1	5.0
	Secondary	1	0.5†
Inductor L3	Outside	1	0.5
Inductor L4	Primary	1	0.5§
	Secondary	1	0.5
Goniometer L5	Left primary	1	0.2§
	Right primary	1	0.2§
	Left secondary	1	0
	Right secondary	1	0
Inductor L6	H1 to T	1	5.5
	H1 to 1.1	1	64
Inductor L7	1 to outside	1	0
Inductor L8 and L9	1 to ground	1	0.5*
Inductor L10 and L11	1 to ground	1	0.5§*
Inductor L12,	Primary	1	0
L13, L14	Secondary	1	70
Inductor L15		1	0
Inductor L16, L17		1	0
Transformer T1	1 to 3	1	0
	2 to 4	1	0
	5 to 6	1	18
	6 to 7	1	18
Transformer T2	1 to 2	1	2.5
	3 to 4	1	0
	4 to 5	1	0

* Each.
§ Less than.
† Each side.

69. NORMAL RESISTANCES OF PARTS (Radio Transmitter BC-446-J) (cont'd)

Power off.

Item	Terminals	Scale Multiplier	Resistance (Ohms)
Transformer T3	1 to 2	1	8
	3 to 4	1	0
	4 to 5	1	0
Transformer T4	1 to 3	1	2
	2 to 4	1	2
	5 to 6	1	55
	6 to 7	1	55
Transformer T5	1 to 2	1	1
	3 to 5	1	0
	6 to 8	1	0
	9 to 11	1	0
Transformer T6	1 to 3	1	6.5
	2 to 4	1	6.5
	5 to 8	1	5
Transformer T7	1 to 2	1	300
	3 to 4	100	850
	4 to 5	100	850
Transformer T8	1 to 2	1	140
	2 to 3	1	150
	4 to 5	1	13
	5 to 6	1	15
Transformer T9	1 to 2	1	70
	2 to 3	1	63
	4 to 5	1	90
Transformer T10	1 to 2	1	2.5
	2 to 3	1	2.5
Transformer T12	Primary	1	55‡
	Secondary	100	5,000‡
Voltage regulator VR1	1 to 2	1	0.5
	2 to 3	1	0.5
Reactor X3		1	10
Reactor X4		1	55
Reactor X5		1	80

‡ Each side of center tap.

70. NORMAL RESISTANCES TO GROUND AT TUBE SOCKETS (Radio Transmitter BC-446-J)

All tubes out of sockets. No external connections to transmitter.

Tube	Electrode	Pin	Scale Multiplier	Resistance (Ohms)	Probable Cause of Incorrect Reading
V1 (JAN-807)	Cathode	4	100	400	Open or shorted resistor R2 Shorted or leaky capacitor C1
	Screen	2	100	2400	Shorted or leaky capacitor C2 Open or shorted resistor R16
	Plate	Cap	100	4500	Open suppressor G1 Open inductor L1 Open resistor R55 Short or ground in switch S8 Shorted or grounded resistors R14, R15, R16 Open resistors R14, R15, R16 Grounded reactor X5 Grounded transformer T3
	Filament	1	1	0	Open filament winding on transformer T5
	Filament	5	1	0	Poor ground connection
	Grid	3	1000	1 megohm	Ground switch S1 Open or shorted resistor R1
V2 (JAN-807)	Cathode	4	1	0	Poor ground connection
	Screen	2	1000	7000	Shorted or leaky capacitor C6 Open or shorted resistor R5 Keyer identification switch may be open
	Plate	Cap	1000	7000	Open suppressor G2 Open inductor L2 Open resistor R56 Short or ground in switch S8 Defect in auxiliary plate rectifier
	Filament	1	1	0	Open filament winding on transformer T5
	Filament	5	1	0	Poor ground connection
	Grid	3	1000	40,000	Shorted or leaky capacitor C4 Open inductor L1 Open or shorted resistor R3 Defect in bias and relay rectifier unit
V3, V4 (JAN-805)	Filament	F	1	4.5	Open or grounded filament winding, transformer T5 Open, shorted, or grounded resistor R57
	Grid	G	1000	13,000	Open or grounded resistor R6 Shorted or leaky capacitor C7 Shorted or leaky capacitor C8
	Plate	Cap	1000	59,000	Shorted or leaky capacitor C14 Open reactor X3 Open or grounded secondary on transformer T9 Grounded transformer T2 Open or shorted resistors R11, R12, R13, R59 Open or grounded primary on transformer T9
V5, V6 (JAN-805)	Filament	F	1	4.5	Open or grounded filament winding on transformer T5 Open, shorted, or grounded resistor R58

70. NORMAL RESISTANCES TO GROUND AT TUBE SOCKETS (cont'd)

All tubes out of sockets. No external connections to transmitter.

Tube	Electrode	Pin	Scale Multiplier	Resistance (Ohms)	Probable Cause of Incorrect Reading
V5, V6 (Jan-805) (Cont'd)	Grid	G	1	15	Open, shorted, or grounded secondary winding on transformer T8
	Plate	Cap	1000	59,000	Open or grounded primary or secondary on transformer T9 Defect in main plate rectifier unit
V7 (JAN-807)	Cathode	4	1	200	Open or shorted resistor R17
	Screen	2	100	4400	Defect in auxiliary plate rectifier unit
	Plate	Cap	100	7500	Open suppressor G4 Open or grounded primary on transformer T8 Defect in auxiliary plate rectifier unit
	Filament	1	1	0	Open filament winding on transformer T5
	Filament	5	1	0	Poor ground connection
	Grid	3	1 100 100	app. 0.5 app. 900 app. 650	Tone gain control at 0 Tone gain control at 6.5 Tone gain control at 10 } Defective control R31
V8 (JAN-807)	Cathode	4	1	200	Open or shorted resistor R17
	Screen	2	100	4400	Defect in auxiliary plate rectifier unit
	Plate	Cap	100	7500	Open suppressor G3 Open or grounded primary on transformer T8 Defect in auxiliary plate rectifier unit
	Filament	1	1	0	Open filament winding on transformer T5
	Filament	5	1	0	Poor ground connection
	Grid	3	1 100 100	app. 0.5 app. 900 app. 650	Tone gain control at 0 Tone gain control at 6.5 Tone gain control at 10 } Defective control R31
V9 (JAN-807)	Cathode	4	100	1000	Open, shorted, or grounded resistor R25 Shorted or leaky capacitor C26
	Screen	2	1000	14,000	Open, shorted, or grounded resistor R27 Open, shorted, or grounded resistor R26 Keyer identification switch may be open Defect in auxiliary plate rectifier unit
	Plate	Cap	1000	12,000	Open suppressor G5 Open or shorted resistor R54 Defect in auxiliary plate rectifier unit
	Filament	1	1	0	Open filament winding on transformer T5
	Filament	5	1	0	Poor ground connection
	Grid	3	1000	120,000	Open inductor L6 Open, shorted, or grounded resistor R24
V10, V11 (JAN-866A/866)	Filament	F	1000	7000	Open or grounded secondary on transformer T3
	Filament	F	1000	7000	Open or grounded reactor X5 Shorted or leaky capacitors C23, C22 Open, shorted, or grounded resistors R14, R15, R16
	Plate	Cap	1	55	Open, shorted, or grounded secondary on transformer T4

70. NORMAL RESISTANCES TO GROUND AT TUBE SOCKETS (cont'd)

All tubes out of sockets. No external connections to transmitter.

Tube	Electrode	Pin	Scale Multiplier	Resistance (Ohms)	Probable Cause of Incorrect Reading
V12, V13 (JAN-872A)	Filament	F	1000	58,000	Open or grounded secondary on transformer T2 Shorted or leaky capacitors C24, C25 Open, shorted, or grounded resistors R11, R12, R13 Open resistor R59
	Plate	Cap	1	70	Open, shorted, or grounded reactor X4 Open or grounded secondary on transformer T1 Open coil on relay E8
V14, V15 V16, V17 (JAN-0D3/VR-150)	Cathode	2	1000	12,800	Defect in bias and relay rectifier unit
V18 (JAN-6H6/G)	Filament	2	1	0	Open secondary on transformer T5
	Filament	7	1	0	Poor ground connection
	Cathodes	8, 4	1000	31,000	Switch S8 not in LINK CURR. position Open, shorted, or grounded resistor R61 Shorted or leaky capacitor C71
	Plates	3, 5	1	70	Open, shorted or grounded secondary on inductor L12
V19 (JAN-6H6/G)	Filament	2	1	0	Poor ground connection
	Filament	7	1	0	Open secondary on transformer T5
	Cathodes	8, 4	1000	85,000	Switch S8 not in LEFT SEC. CURR. position Open, shorted or grounded resistor R63 Shorted or leaky capacitor C72
	Plates	3, 5	1	70	Open, shorted, or grounded secondary on inductor L13
V20 (JAN-6H6/G)	Filament	2	1	0	Poor ground connection
	Filament	7	1	0	Open secondary on transformer T5
	Cathodes	8, 4	1000	85,000	Switch S8 not in RIGHT SEC. CURR. position Open, shorted, or grounded resistor R65 Shorted or leaky capacitor C73
	Plates	3, 5	1	70	Open, shorted, or grounded secondary on inductor L14

71. NORMAL RESISTANCES TO GROUND FROM IMPORTANT CIRCUIT TERMINATIONS (Radio Transmitter BC-446-J)

All tubes in sockets. No external connections to the transmitter.

Unit	Terminal No.	Scale Multiplier	Resistance (Ohms)
R-f chassis	1	1000	Infinite
	2	1000	Infinite
	3	100	7,500
	4	100	4,400
	5	100	13,500
	6	100	4,400
	7	1000	13,000
	8	1	0
	9	1	0

71. NORMAL RESISTANCES TO GROUND FROM IMPORTANT CIRCUIT TERMINATIONS (Radio Transmitter BC-446-J) (cont'd)

All tubes in sockets. No external connections to the transmitter.

Unit	Terminal No.	Scale Multiplier	Resistance (Ohms)
R-f chassis (cont'd)	10	1	4.5
	11	1	4.5
	12	100	2,800
	Junction of C14, C16	1	1.0
	Term. S on L2 term. strip	100	14,000
	Term. N on L2 term. strip	100	14,000
	Term. R on L1 term. strip	1000	40,000
	Term. S on L1 term. strip	1000	40,000
A-f chassis	1	1000	5,000
	2	100	2,500
	3	1000	Infinite
	4	1	0
	5	1	5.0
	6	1	5.0
	7	1	0
	8	1000	7,000
	9	1000	4,000
	10	1000	4,000
	11	1000	Infinite
	12	1000	Infinite
	Voice input Term. strip	1	60 each
Meter and control assembly, side terminal strip	1	1000	Infinite
	2	1	0
	3	1	60
	4	100	4,500
	5	1	18.5
	6	1	0.5
	7	100	700
	8	1	12
	9	1000	45,000
	10	1	1.0
	11	100	650
Meter and control assembly, rear terminal strip	1	100	4,500
	2	1000	Infinite
	3	1000	Infinite
	4	1	60
	5	100	7,500
	6	100	7,500
	7	1	0
	8	1	0
	9	1000	Infinite
	10	1000	Infinite
	11	100	4,500
	12	1	4.5
	13	1	0
	14	1000	Infinite
	15	100	5,500
A-c input and remote control terminal strip	1	1	53
	2	1	55
	3	1	0
	4	1	45
	5	1	45
	6	1000	Infinite
	7	1000	Infinite

71. NORMAL RESISTANCES TO GROUND FROM IMPORTANT CIRCUIT TERMINATIONS (Radio Transmitter BC-446-J) (cont'd)

All tubes in sockets. No external connections to the transmitter.

Unit	Terminal No.	Scale Multiplier	Resistance (Ohms)
Radio range keyer terminal strip	110 v d-c −	1000	5,000
	110 v d-c +	no connection	
	Link circuits relay Z	1000	5,000
	Link circuits relay Y	100	510
	Transmitter keying circuits A	100	4,400
	Transmitter keying circuits B	100	400
	110 a-c v 1	1000	Infinite
	110 a-c v 2	1000	Infinite
Radio range keyer meter		1000	Infinite
		1000	Infinite
Blower terminal strip	1	1000	Infinite
	2	1000	Infinite
	3	1000	Infinite
	4	1000	Infinite
Auxiliary plate rectifier chassis terminal strip	1	1000	Infinite
	2	1000	Infinite
	3	100	7,500
	4	1	52
	5	1000	Infinite
	6	1000	Infinite
	7	1	0
	8	1	60
Bias voltage regulator chassis terminal strip	1	1	0
	2	1000	15,000
Second shelf interconnecting terminal strip	1	1	0
	2	100	5,500
	3	100	4,400
	4	1000	Infinite
	5	100	7,500
	6	1000	59,000
	7	1000	Infinite
	8	100	500
	9	1000	Infinite
	10	1000	Infinite
Main plate rectifier chassis terminal strip	1	1000	60,000
	2	1	77
	3	1	77
	4	1000	Infinite
	5	1000	Infinite
	6	1000	Infinite
	7	1000	Infinite
	8	1000	Infinite
	9	1000	Infinite
	10	1	0
	11	1000	Infinite
	A	1000	Infinite
	B	1000	Infinite
	C	1000	Infinite
	D	1000	Infinite
Relay and bias rectifier chassis	1	1000	Infinite
	2	100	4,400
	3	1000	Infinite

71. NORMAL RESISTANCES TO GROUND FROM IMPORTANT CIRCUIT TERMINATIONS (Radio Transmitter BC-446-J) (cont'd)

All tubes in sockets. No external connections to the transmitter.

Unit	Terminal No.	Scale Multiplier	Resistance (Ohms)
Relay and bias rectifier chassis (cont'd)	4	1000	12,500
	5	1	0
	6	100	5,200
Keyer inter-connecting terminal strip	1	1000	Infinite
	2	1000	Infinite
	3	100	4,200
	4	100	4,200
	5	100	550
	6	100	5,200
	7	1000	Infinite
Link current meter rectifier	1	100	2,500*
	2	1	0*
	3	1	0*
Right current meter rectifier	1	100	2,500†
	2	1	0†
	3	1	0†
Left current meter rectifier	1	100	2,500‡
	2	1	0‡
	3	1	0‡
Resistor R4	Bottom	1000	14,500
	Top	1000	15,000
Resistor R16	Bottom	100	2,800
	Top	1	0
Resistor R15	Bottom	100	2,800
	Top	100	4,500
Resistor R14	Bottom	100	7,500
	Top	100	4,400
Resistor R11	Bottom	1000	60,000
	Top	1000	40,000
Resistor R12	Bottom	1000	20,000
	Top	1000	40,000
Resistor R13	Bottom	1000	20,000
	Top	1	60

* D.C. METER SWITCH in LINK CURR. position.
† D.C. METER SWITCH in LEFT SEC. CURR. position.
‡ D.C. METER SWITCH in RIGHT SEC. CURR. position.

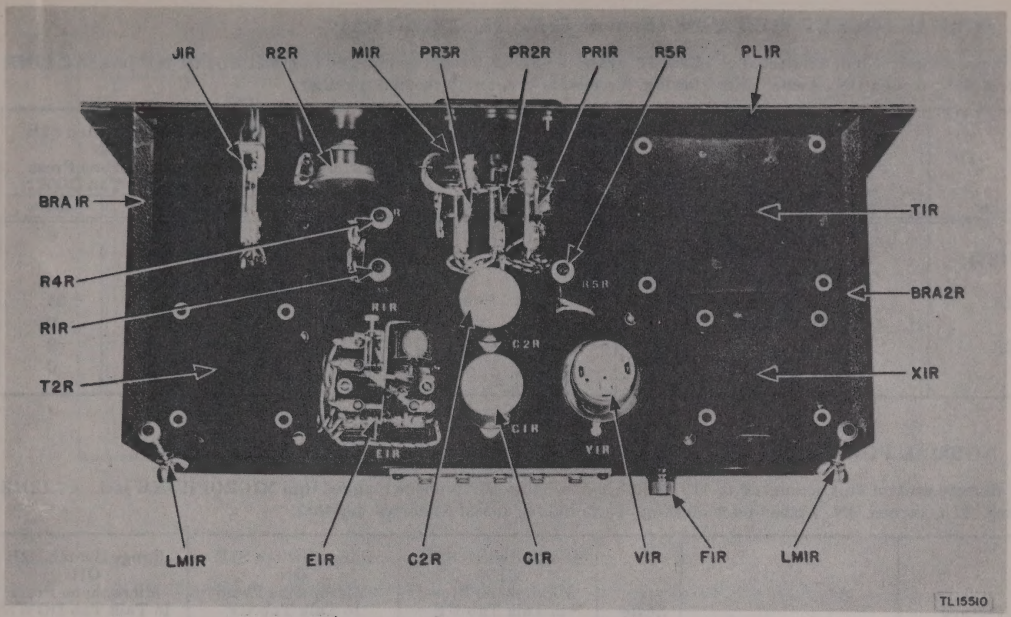


Figure 68. Remote Control Unit RM-45-A, top view, cover removed.

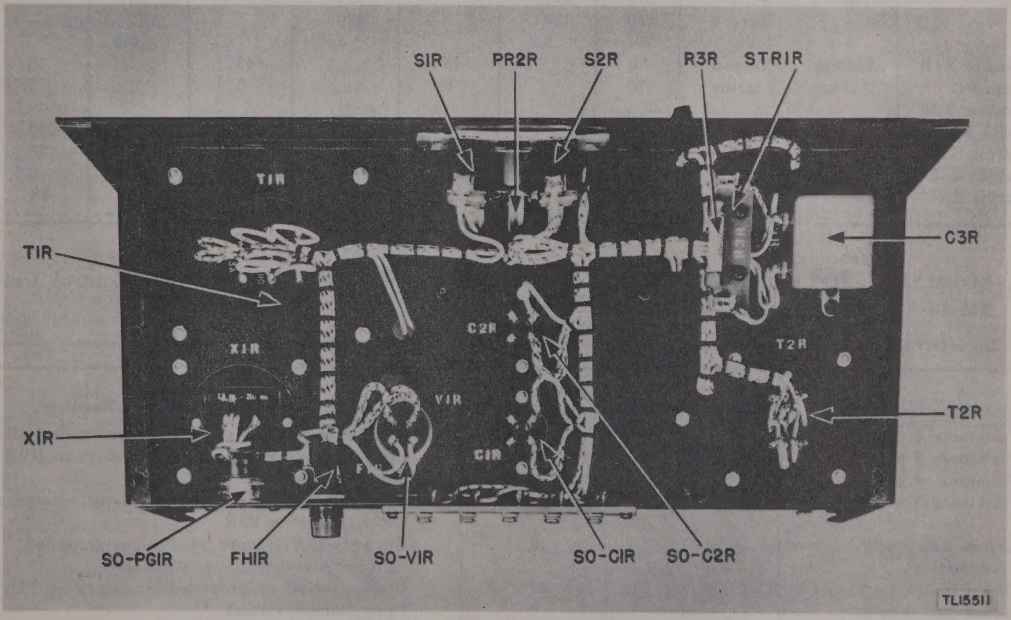


Figure 69. Remote Control Unit RM-45-A, bottom view, cover removed.

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72. NORMAL SOCKET VOLTAGES (Remote Control Unit RM-45-A)

Remote control unit connected to 110 v, 60 cycle, a-c line. Microphone plugged into MICROPHONE jack. AC LINE switch, S1R, turned ON. Amber pilot glowing. Terminals 3, 4, and 5 shorted together.

Socket	From	To	Scale v	Range Switch S2R OFF Microphone Press to Talk Tab UP		Range Switch S2R ON Microphone Press to Talk Tab UP		Range Switch S2R ON Microphone Press to Talk Tab DOWN	
				a-c v	d-c v	a-c v	d-c v	a-c v	d-c v
V1R	1	Term. 3		0	0	0	0	0	0
(5Z3)	4	Term. 3	10	5.2		5.2		5.2	
	2	Pin 3	250	220		220		220	
C1R	1	Term. 3	50		−40		−34		−30
	2	Term. 3			0		0		0
C2R	1	Term. 3			0		0		−2
	2	Term. 3			0		0		0

73. NORMAL POINT-TO-POINT VOLTAGES (Remote Control Unit RM-45-A)

Remote control unit connected to 110 v, 60 cycle, a-c line. Microphone plugged into MICROPHONE jack. AC LINE switch, S1R, turned ON. Amber pilot glowing. Terminals 3, 4, and 5 shorted together.

Voltage measured	From	To	Scale v	Range Switch S2R OFF Microphone Press to Talk Tab UP		Range Switch S2R ON Microphone Press to Talk Tab UP		Range Switch S2R ON Microphone Press to Talk Tab DOWN	
				a-c v	d-c v	a-c v	d-c v	a-c v	d-c v
Transformer T1R	Across 115 v terms		250	115		115		115	
	110	0	250	120		120		120	
	0	Term 3	250	120		120		120	
	5 v	3A	10	5.2		5.2		5.2	
Reactor X1R	250 ma	Term 3	50		48		43		40
Transformer T2R	Across 50 v terms		10		0		0		0.75
Relay E1R	Across coil		50		0		0		30
Across R1R			50		40		34		28
Across R4R			10		0		0		2.5
Across R5R			50		15		17		18

74. NORMAL RESISTANCES AT IMPORTANT CIRCUIT TERMINATIONS (Remote Control Unit RM-45-A)

No external connections to remote control unit. S1R and S2R closed. Microphone disconnected.

Resistance Measured	Scale Multiplier	Resistance (Ohms)	Probable Cause of Incorrect Reading
Terminals 1 to 3	1	80	Open, grounded, or shorted secondary on T2R
Terminals 2 to 3	1	90	Open, grounded, or shorted secondary on T2R
Terminals 4 to 3	1000	Infinite	Short circuit
Terminals 5 to 3	100	450	Burned out P3R, open, shorted, or grounded R1R, defective S2R
Across A.C. input terminal	1	9	Burned out F1R, open, shorted, or grounded primary on T1R, defective S1R
Socket pins 2 to 3	1	44	Open, shorted, or grounded secondary on T1R
Socket pins 1 to 4	1	0	Open filament circuit
Transformer terminal 0 to terminal 3	100	400	Open, shorted, or grounded R5R Open, shorted, or grounded X1R Open, shorted, or grounded R1R

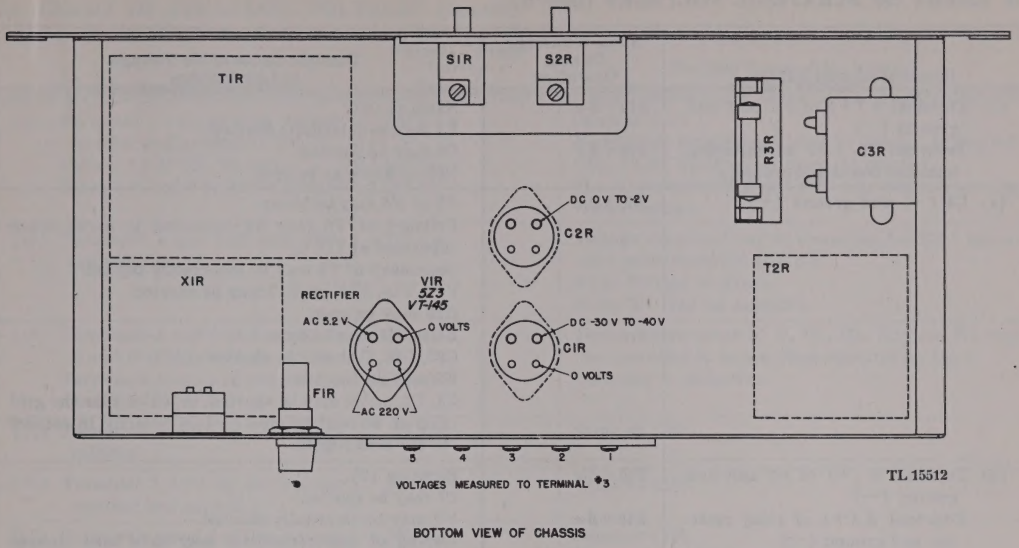

Figure 70. Remote Control Unit RM-45-A, tube and capacitor layout diagram.

75. NORMAL RESISTANCES OF PARTS (Remote Control Unit RM-45-A)

Part	Points measured across	Scale Multiplier	Resistance (Ohms)	
Transformer T1R	Primary 115	1	8.5	
	110 110	1	44	
	5v 3A	1	0	
Transformer T2R	Primary	1	8	
	Secondary	1	170	
Relay E1R	Coil	1000	13,000	
Reactor X1R	Across coil	1	55	
Microphone	Tip Ring	1	approx. 30	With PRESS TO TALK switch closed

76. CHART OF STRATEGIC VOLTAGES

Note.—Possible causes of no voltage or low voltage apply to all conditions in related box under heading "Points Measured Across."

Points Measured Across	Normal Voltage During Operation	Possible Cause of No Voltage or Low Voltage
(1) Terminals 1 and 2 of r-f unit	115 v a-c	Transformer T10 may be connected for 230 volts when operated at 115 volts. F1 or F2 may be blown.
(2) Terminal 3 (+) of r-f unit and ground (−) Terminal 6 (+) of metering terminal board and ground	480 v d-c	F5 or F6 may be blown. C22 or C23 may have broken down. Tube 866-A may be defective or one may not be operating. Voltage regulator may be connected for 230 volts when operated at 115 volts thus lowering the filament voltage of the 866-A. Primary of transformer T4 may be connected for 230 v when operated at 115 v. R56, E6, S10, S11, or TH3 may be open.

76. CHART OF STRATEGIC VOLTAGES (cont'd)

Points Measured Across	Normal Voltage During Operation	Possible Cause of No Voltage or Low Voltage
(3) Terminal 4 (+) of r-f unit and ground (−) Terminal 11 (−) of metering terminal board and ground (−)	245 v d-c 245 v d-c	Same as (2). V1 may be internally shorted. C3 may be shorted. R55 or R14 may be open.
(4) C4 (−) and ground (+)	260 v d-c	F3 or F4 may be blown. Primary of T6 may be connected in series when operated at 115 v. Secondary of T6 may be incorrectly tapped. V14, V15, V16, or V17 may be shorted. R18 may be open. Relay E4 may be open. C27, C28, C29 may be shorted. E2 may be shorted. C3, C4, or V2 may be shorted, in which case the grid side of R3 will become (+) in polarity in respect to the bias supply.
(5) Terminal 6 (+) of r-f unit and ground (−) Terminal 2 (+) of relay rectifier and ground (−)	245 v d-c 245 v d-c	Same as (2). C6 may be shorted. V2 may be internally shorted. Keying of the transmitter may have been stopped with the key of E1 open in which case terminal 6 will become (−) in polarity with respect to ground.
(6) Terminal 7 (−) of r-f unit and ground (−)	170 v d-c	Same as (4). R4 may be open. C8, C7, V3, or V4 may be shorted in which case terminal 7 will become (+) in respect to the bias of R4.
(7) Terminal 9 of r-f unit and ground Terminals 10 and 11 of r-f unit Terminal 2 of metering rectifiers and ground	6.2-6.3 v a-c 9.9-10 v a-c 6.2-6.3 v a-c	VR1 may be connected for 230 v operation when operated at 115 v. F7 or F8 may be blown.
(8) Terminal 12 (+) of r-f unit and ground (−)	145 v d-c	Same as (2). V1 may be shorted. R16 may be shorted. C2 may have broken down. R15 may be open.
(9) Terminals 5 and 6 of audio unit Terminal 7 of audio unit and ground	9.8-10 v a-c 6.2-6.3 v a-c	Same as (7).
(10) Terminal 8 (+) of audio unit and ground (−)	480 v d-c	Same as (2). V7, V8, or V9 may be internally shorted.
(11) Terminal 9 (+) of audio unit and ground (−)	245 v d-c	Same as (5). R26, R27, or V9 may be shorted.
(12) Terminal 10 (+) of audio unit and ground (−) Terminal 1 (+) of metering terminal board	245 v d-c 245 v d-c	Same as (2). V7 or V8 may be shorted.
(13) Terminals 2 and 3 of high voltage rectifier Terminals 1 and 2 of high voltage rectifier	2,660 v a-c 1,100 v a-c	F11 or F12 may be blown. Primary of transformer T1 may be connected in series when operated at 115 volts. V12 or V13 may be shorted. C24 or C25 may be shorted with breaker E8 defective or X4 shorted to ground.

76. CHART OF STRATEGIC VOLTAGES (cont'd)

Points Measured Across	Normal Voltage During Operation	Possible Cause of No Voltage or Low Voltage
(14) Terminal 1 (+) of high voltage rectifier and ground (−) Plate (+) of V3, V4 and Plate (+) of V5, V6 to ground (−)	1,160 v d-c 1,150 v d-c 1,150 v d-c	Same as (13). Modulation transformer may be shorted to ground. C14, V3, or V4 of r-f unit may be shorted. The filaments of V12 and V13 may not be receiving rated voltage.
(15) Terminals 4 and 5 of high voltage rectifier	115 v a-c	Voltage regulator may be connected for 230 v operation when operated at 115 v. F7 or F8 may be blown. Relay E4 may be defective.
(16) Terminals A and C and terminals B and D of high voltage rectifier Terminals 1 and 5 of low voltage rectifier	115 v a-c 115 v a-c	Temperature below 57 F, H1, H2, H3, and H4 may be connected in series when operated at 155 v. TH1 may be defective.
(17) Terminals 2 and 6 of low voltage rectifier	115 v a-c	Same as (15).
(18) Terminal 3 (+) of low voltage rectifier and ground (−)	480 v d-c	Same as (10).
(19) Terminals 4 and 8 of low voltage rectifier	1,200 v a-c	Same as (10). F5 or F6 may be blown. Primary of transformer T4 may be connected in series when operated at 115 v.
(20) Terminals 2 and 3 of relay rectifier	115 v a-c 230 v a-c	F3 and F4 may be blown.
(21) Terminal 4 (−) of relay rectifier and ground (+)	150 v d-c	Same as (4).
(22) Terminal 6 (−) of relay rectifier and ground (+) Terminal 15 (−) of metering terminal board and ground (+)	100-135 v d-c with keyer arm right 100-130 v d-c with keyer arm left	Same as (4).
(23) Terminals 2 and 3 metering terminal board	115 v a-c	Same as (4).
(24) Terminal 4 (+) of metering terminal board and ground (—)	1.22 v d-c	R11, R12, or R13 may be open. R59 may be shorted.
(25) Terminal 5 (+) of metering terminal board and ground (−)	480 v d-c	Same as (10).
(26) Terminal 7 (+) of metering terminal board and ground (−)	1 v d-c	R58 may be shorted. V5 and V6 may not be driven by the previous stage.
(27) Terminal 12 (+) of metering terminal board and ground	1.03 v d-c	R57 may be shorted. V3 and V4 may not be driven by the previous stage.
(28) A-c input terminals of keyer E1	115 v a-c	F9 or F10 may be blown. Relay E4 may be open.
(29) Terminals W (+) and Y (−) Terminals W (+) and Z (−) of link circuit relay	Arm Left / Arm Right 100 v d-c / 0 d-c 100 v d-c / 135 d-c	Same as (4).
(30) Coil of E4	115 v a-c	T10 may be connected for 230 v operation when operated at 115 v. F1 or F2 may be blown. TH4 will be open if transmitter temperature is over 160 F. If operated by remote control E9 may not be energized.

76. CHART OF STRATEGIC VOLTAGES (cont'd)

Points Measured Across	Normal Voltage During Operation	Possible Cause of No Voltage or Low Voltage
(31) Coil of E5	115 v a-c	Same as (15).
(32) Coil of E6	115 v a-c	E5 may be open. Door-switch S10 or S11 may be open. TH3 will be open if transmitter temperature is under 50 F. F1 or F2 may be blown. T10 may be connected for 230 v operation when operated at 115 v.
(33) Coil of E10 Coil of E11	0 volts when transmitter is operated as range 115 v when transmitter is operated for voice transmission	E7 may not be operating. T10 may be connected for 230 v when operated at 115 v. F1 or F2 may be blown.
(34) Fan terminals	115 v a-c 230 v a-c	F14 or F15 may be blown. TH2 will be open if transmitter temperature is under 60 F.
(35) C6 (+) on r-f unit and ground (−)	220 v d-c	Same as (5). R5 may be open.
(36) Plate of V9 (+) on audio unit and ground	380 v d-c	Same as (10). R54 or suppressor G5 may be open.
(37) Junction of R26 and R27 (+) of audio chassis and ground (−)	113 v d-c	Same as (11). R26 may be open. R27 may be open in which case there will be over 200 v across R27 and ground.
(38) Terminals 7 and 11 of control unit terminal board	12 v audio when transmitter is used as radio range	C69 may be shorted. R31 may be shorted. Secondary of T7 may be open. Audio oscillator may not be oscillating.
(39) Terminals 4 and 8 of control unit terminal board	12 v audio when transmitter is used for voice operation	R29 may be shorted. Secondary of T12 may be open. Voice line may be defective.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock†	Region Stock†
Fig. 4	2C6386J	RADIO TRANSMITTER BC-446-J: 200 to 400 kc, 100 w, including remote control unit.		BC-446-J (R5) RM-45-A (R5)		
	2C6386J/B1	TECHNICAL MANUAL TM 11-811.	2	(R5)		*
B1	3H404-3	BLOWER ASSEMBLY: blades, 10", 34 degree pitch; motor, 115/230 v, 60 cps.	1	P-1034 (T5) 6314 (R9)		*
C1, C2	3DKA10-204	CAPACITOR: mica, 0.01 mfd, 600 v d-c working.	8	XMBW.6-11-10 (S5)	*	*

*Indicates stock available.
†Parts not stocked in station or region stock are carried in depot stock.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A (cont'd)

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock†	Region Stock†
C3	3K5510321	CAPACITOR: mica; 0.01 mfd, 1,200 v d-c working.	2	XMBW1.2-11-10 (S5)	*	*
C4	3DKA10-204	CAPACITOR: same as C1.				
C5	3D9040V-1	CAPACITOR: variable; air, single-section, 40-1,050 mmfd, 0.030" air gap, mycalex.	2	XR-1050-PS (C2) PL8203		
C6	3DKA10-204	CAPACITOR: same as C1.				
C7	3K5510321	CAPACITOR: same as C3.				
C8	3DKA10-204	CAPACITOR: same as C1.				
C9	3D9016-1	CAPACITOR: air; 16 mmfd.	1	466-C9 (R5)		
C10	3D9040V-1	CAPACITOR: same as C5.				
C11	3K6510122	CAPACITOR: mica; 0.0001 mfd, 3,000 v rms test.	1	XRBW3-31-5 (S5)		*
C12, C13	3DKA10-204	CAPACITOR: same as C1.				
C14	3DA4-13	CAPACITOR: mica; 0.004 mfd, 5,000 v rms.	1	XSBW5-24-5 (S5)		*
C15, C16	3DA1-38	CAPACITOR: mica; 0.001 mfd, 8,000 v rms test.	10	XHCW8-21-2 (S5)	*	*
C17	3DA1.013	CAPACITOR: variable; air, 1,020 mmfd, 0.090" air gap, mycalex.	3	TH1020US (C2) PL 9005		
C18	3D9500-34.1	CAPACITOR: mica; 0.0005 mfd, 5,000 v rms.	3	XSCW5-35-5 (S5)	*	*
C19, C20	3K7010222	CAPACITOR: mica; 0.001 mfd, 5,000 v rms.	4	XSCW5-21-5 (S5)	*	*
C22, C23	3DB6-4	CAPACITOR: paper; oil, 6 mfd, 1,000 v d-c working.	2	XLSC10-6 (S5)		*
C24, C25	3DB6-5	CAPACITOR: paper; oil, 6 mfd, 2,000 v d-c working.	2	XLSC20-6 (S5)		*
C26 thru C29	3DB4-26	CAPACITOR: paper; oil, 4 mfd, 600 v d-c working.	4	XLSC6-4 (S5)	*	*
C30	3DA1.013	CAPACITOR: same as C17.				
C31	3D9500-34.1	CAPACITOR: same as C18.				
C32	3K7010222	CAPACITOR: same as C19.				
C33, C34	3DA2-47	CAPACITOR: mica; 0.002 mfd, 6,000 v rms.	4	XSCW6-22-2 (S5)	*	*
C35	3DA1.013	CAPACITOR: same as C17.				
C36	3D9500-34.1	CAPACITOR: same as C18.				
C37	3K7010222	CAPACITOR: same as C19.				
C38, C39	3DA2-47	CAPACITOR: same as C33.				
C40	3D9040V	CAPACITOR: variable; air, dual-section, 40-540 mmfd, per section, 0.230" air gap.	2	PK-544-QD1 (C2) PL 9200		
C41, C42	3DA1-38	CAPACITOR: same as C15.				
C43, C44	3D9500-122	CAPACITOR: mica; 0.0005 mfd, 8,000 v rms.	8	XHCW8-35-5 (S5)	*	*

*Indicates stock available.
†Parts not stocked in station or region stock are carried in depot stock.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A (cont'd)

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock†	Region Stock†
C45	3D9250-19	CAPACITOR: mica; 0.00025 mfd, 8,000 v rms.	4	XHCW8-325-5 (S5)	*	*
C46, C47	3DA1.013	CAPACITOR: same as C15.				
C48, C49	3D9500-122	CAPACITOR: same as C43.				
C50	3D9250-19	CAPACITOR: same as C45.				
C51	3D9040V	CAPACITOR: same as C40.				
C52, C53	3DA1.013	CAPACITOR: same as C15.				
C54, C55	3D9500-122	CAPACITOR: same as C43.				
C56	3D9250-19	CAPACITOR: same as C45.				
C57, C58	3DA1.013	CAPACITOR: same as C15.				
C59, C60	3D9500-122	CAPACITOR: same as C43.				
C61	3D9250-19	CAPACITOR: same as C45.				
C62	3DA2-119	CAPACITOR: mica, 0.002 mfd, 1,200 v d-c working.	1	XMJW1.2-22-10 (S5)		*
C63	3DA4-45	CAPACITOR: mica; 0.004 mfd, 1,200 v d-c working.	1	XMJW1.2-24-5 (S5)		*
C64	3DA8-13	CAPACITOR: mica; 0.008 mfd, 1,200 v d-c working.	1	XMJW1.2-28-5 (S5)		*
C65	3DKA10-204	CAPACITOR: same as C1.				
C66	3DA22-4	CAPACITOR: mica; 0.022 mfd, 300 v d-c working.	1	XMBW.3-122-4 (S5)		*
C67, C68	3DA37.500	CAPACITOR: mica; 0.0375 mfd, 300 v d-c working.	2	XMDW.3-1375-4 (S5)	*	*
C69	3DA50-126	CAPACITOR: paper; oil, 0.05 mfd, 300 v d-c working.	1	XDRM3-.15 (S5)		*
C70	3DA100-174	CAPACITOR: paper; oil, 0.1 mfd, 2,000 v d-c working.	1	XLSC2-.1 (S5)		*
C71, C72, C73	3D9500-64	CAPACITOR: mica; 0.0005 mfd, 500 v d-c working.	3	MOBW1422-22 (S5)	*	*
X3	3C335-5	CHOKE: r-f; 15 millihenries at 300 ma, 12 ohms d-c.	1	C-2526-1 (R5)		*
X4	3C335-3	CHOKE: filter, 6 h at 0.7 amp, 60 ohms d-c.	1	466-X4 (S28)		*
X5	3C335-4	CHOKE: filter; 8 h at 0.5 amp, 100 ohms d-c.	1	466-X5 (S28)		*

*Indicates stock available.
†Parts not stocked in station or region stock are carried in depot stock.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A (cont'd)

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock†	Region Stock†
L1	2C6386J/C1	COIL ASSEMBLY: crystal; oscillator tank; primary: 4.7 millihenries, 6 ohms d-c; secondary: 725 microhenries, 1 ohm d-c.	1	466-L1 (R5)		
L2	2C638J/C7	COIL ASSEMBLY: i-p-a; tank; primary; 4.2 millihenries, 6 ohms d-c; secondary: 600 microhenries, 1 ohm d-c.	1	466-L2 (R5)		
L3	2C6386J/C8	COIL ASSEMBLY: p-a; tank variometer, 90-290 microhenries, 0.8 ohm d-c.	1	466-L3 (R5)		
L4	2C6386J/C3	COIL ASSEMBLY: output; vario-coupler; primary: 30 microhenries, 0.3 ohm d-c; secondary: 190 microhenries, 0.8 ohms d-c, mutual 35 microhenries.	1	466-L4 (R5)		
L5	2C6386J/G1	COIL ASSEMBLY: goniometer; primary: 95 microhenries; secondary: 35 microhenries mutual, maximum 17 microhenries.	1	466-L5 (R5)		
L6	3C335-2	COIL ASSEMBLY: tone oscillator tank; 1 h, tapped 12.5% turns, adjustable taps from 1.1 to 0.9 h, 70 ohms d-c.	1	466-L6 (S28)		*
L7	2C6386J/C2	COIL ASSEMBLY: quarter-phasing; 88 microhenries, tapped 67, 62, 54, 45, 38, 22 microhenries, 0.36 ohm d-c.	1	466-L7 (R5)		
L8, L9	2Z9626.14	COIL ASSEMBLY: goniometer; primary: tower matching, auto-transformer; L primary: 420 microhenries tapped 1.33, 1.6, 2.0, 2.66 ratios, 0.75 ohm d-c.	2	466-L8 (R5)		
L10, L11	2C6386J/C4	COIL ASSEMBLY: goniometer; secondary: tower loading; L secondary: 65 microhenries, 0.3 ohm d-c.	2	466-L10 (R5)		
L12, L13, L14	2Z9900.11	COIL ASSEMBLY: link circuit; current transformer, adjustable iron core; primary: 5 microhenries, 0.05 ohm d-c; secondary: 13 millihenries, 75 ohms d-c.	3	466-L12 (R5)		
L15	2C6386J/C5	COIL ASSEMBLY: fixed output coupler; 30 microhenries, 0.3 ohm d-c.	1	466-L15 (R5)		
L16, L17	2C6386J/C6	COIL ASSEMBLY: goniometer; primary loading; 14 microhenries, 0.1 ohm d-c.	2	466-L16		
AF1	6Z3856-28	FILTER: air; fiberglass, 16" x 20" x 1".	1	(05)	*	*
AF2	6Z3856-2	FILTER: air; fiberglass, 10" x 20" x 1".	1	(05)	*	*
F1, F2	3Z1901-3	FUSE: cartridge; renewable, 3 amp, 250 v, fuse link, (3Z3003) 3 amp, 250 v (for use on 220 v power).	4	(J2)	*	*
F3, F4	3Z1901-1	FUSE: cartridge; renewable, 1 amp, 250 v, 9/16" diam x 2" long, fuse link, (3Z3001-1) (1 amp, 250 v).	2	(J2)	*	*
F5, F6	3Z1901-3	FUSE: same as F1.				

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†Parts not stocked in station or region stock are carried in depot stock.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A (cont'd)

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock‡	Region Stock†
F7, F8	3Z1931	FUSE: cartridge; renewable, 10 amp, 115 v, 9/16" diam x 2" long; fuse link, (3Z3005) 5 amp, 250 v (for use on 220 v power); fuse link, (3Z3010) 10 amp, 115 v (for use on 115 v power).	4	(J2)	*	*
F9, F10	3Z2601.21	FUSE: cartridge; non-renewable, 1 amp, 250 v.	2	(B9)	*	*
F11, F12	3Z1931	FUSE: same as F7.				
F13	3Z2571	FUSE: cartridge; non-renewable, 1/100 amp, 250 v, type 8AG.	1	1001 (L3)	*	*
F14, F15	3Z1901-5.1	FUSE: cartridge; renewable, 5 amp, 115 v, 9/16" diam x 2" long (for use on 155 v power); 3 amp, 250 v (for use on 220 v power).	4	(J2)		
H1, H2, H3, H4	2Z5017	HEATER: tube; 100 w, 110 v.	4	B-131-70A (W1)	*	*
H5	2Z5016	HEATER: 40 w, 110 v, non-inductive plaque, 4 5/8 " x 1 3/16", special.	1	(W1)		*
E1	4A1200-75M	KEYER: Radio Range CAA-19 (see list on Radio Range Keyer Sig 10-407).	1	75M (B6)		
P1, P2	2Z5903	LAMP: pilot, 6 w, 120 v, candelabra, screw base.	2	S6 (S19)	*	*
M1	3F895-12	METER: 0-1, 2.5, 5 ma, d-c; 2,400 ohms d-c (0-1 ma).	1	301 (W6)		*
M2	3F8150-82	METER: 0-150 v a-c; iron-vane, 110 ohms.	1	476 (W5)		*
SR1	3H4857-2	RECTIFIER: selenium; 110 v, 0.125 amp, 24 disk.	2	10-D0-160 (I2)		*
VR1	3H497010	REGULATOR: voltage; 115 v a-c, 0.350 kva at 1.0 power factor, 57-63 cps.	1	68G926 (G3)		
E2	2Z7587-35	RELAY: single pole, double throw; polarized, link circuit; field coil: 110 v d-c working, 25 ma; armature coil: 110 v d-c working, 200 ma.	1	2B (B6)		
	2Z7587-35/1	CONTACTS: for relay E2; 3 amp at 300 kc.	1		*	*
E3	3Z9862-2.6	RELAY: overload; thermal; 2 pole, 1 position, 30 amp, 125 v.	1	CH1062 (G3)		
E4	2Z7590-39	RELAY: contactor; power; double pole, single throw, 1 break, normally open; coil: 115 v, 135 ma, 60 cps.	2	8BXX12 (S13)		
	2Z7590-39/1	CONTACTS: for relay E4; 30 amp at 230 v a-c.			*	*

†Parts not stocked in station or region stock are carried in depot stock.
*Indicates stock available.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A (cont'd)

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock†	Region Stock†
E5	2Z7598-4	RELAY: time delay 30 sec; normally open; coil: 115 v, 60 ma, 60 cps.	1	466-E5 (R5)		
E6	2Z7590-39	RELAY: Same as E4.				
E7	2ZK7658-16	RELAY: magnetic; single pole, double throw, normally open, coil: 50 ohms, 20 ma.	2	BD30 (A5)		
	2ZK7658-16/1	CONTACTS: for relay E7; 5 amp at 110 v a-c.			*	*
E8	2Z7599-13	RELAY: overload; single pole, single throw, 1 break, normally cosed; coil: 550-650 ma, d-c.	1	0411 (H6)		
E9	2ZK7658-16	RELAY: same as E7.				
E10	2Z7593-30	RELAY: audio-frequency; 3 poles, double throw, 1 break; coil: 115 v a-c; 75 ma, 60 cps.	1	Box		
	2Z7593-30/1	CONTACTS: for relay E10; 5 amp.	1		*	*
E11	2Z7590-38	RELAY: r-f; normally open 2, normally closed 3, double break; coil: 115 v a-c, 160 ma, 60 cps.	1	100-A (P28)		
	2Z3191-15	CONTACTS: for relay E11; 20 amp.			*	*
R1	3Z6801-78	RESISTOR: carbon; 1 megohm, 2 w.	3	S1-2 (S6)	*	*
R2	3Z6040-48	RESISTOR: carbon; 400 ohms, 2 w.	1	S1-2 (S6)	*	*
R3	3Z6625-88	RESISTOR: carbon; 25,000 ohms, 2 w.	3	S1-2 (S6)	*	*
R4	3Z6050-115	RESISTOR: wire-wound; 500 ohms, 150 w.	1	(W3)	*	*
R5	3Z6300-122	RESISTOR: carbon; 3,000 ohms, 2 w.	1	S1-2 (S6)	*	*
R6	3Z5050-1	RESISTOR: 250 ohms; 40 w, plaque.	1	(W3)		*
R7, R8	3Z5630	RESISTOR: wire-wound; 50,000 ohms, 150 w.	2	(W3)	*	*
R9, R10	3Z6750-50	RESISTOR: carbon, 500,000 ohms, 2 w.	2	F2 (I2)	*	*
R11, R12, R13	3Z5600-2	RESISTOR: wire-wound; 20,000 ohms, 150 w.	3	(W3)	*	*
R14	3Z5430-1	RESISTOR: wire-wound; 3,000 ohms, 150 w.	2	(W3)	*	*
R15	3Z6200-104	RESISTOR: wire-wound; 2,000 ohms, 150 w.	1	(W3)	*	*
R16	3Z5430-1	RESISTOR: same as R14.				
R17	3Z5000-2	RESISTOR: wire-wound; 200 ohms, 25 w.	1	(W3)	*	*
R18	3Z6610-154	RESISTOR: carbon; 10,000 ohms, 2 w.	1	S1-2 (S6)	*	*
R19	3Z6650-112	RESISTOR: carbon; 50,000 ohms, 2 w.	2	S1-2 (S6)	*	*

*Indicates stock available.
†Parts not stocked in station or region stock are carried in depot stock.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A (cont'd)

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock†	Region Stock†
R20, R21, R22, R23	3Z6050-116	RESISTOR: carbon; 500 ohms, 2 w.	4	(S6)	*	*
R24	3Z6700-118	RESISTOR: carbon; 100,000 ohms, 2 w.	1	S1-2 (S6)	*	*
R25	3Z6100-146	RESISTOR: carbon; 1,000 ohms, 2 w.	1	S1-2 (S6)	*	*
R26	3Z6625-88	RESISTOR: same as R3.				
R27	3Z6625-88	RESISTOR: same as R3.				
R28	3Z6725-4	RESISTOR: carbon; 250,000 ohms, 2 w.	1	F2 (I2)	*	*
R29	2Z7284.50	RESISTOR: potentiometer; dual, 50,000 ohms, ½ w, log taper.	1	37 (C10)	*	*
R30	3Z6650-112	RESISTOR: same as R19.				
R31	2Z7284.51	RESISTOR: potentiometer; dual, 3,000 ohms, 2.5 w.	1	P58-3000 (C10)		*
R32, R33	3Z4801-2	RESISTOR: 1 ohm; 40 w, non-inductive plaque.	2	(W3)	*	*
R34	3Z4802-2	RESISTOR: 2 ohms; 40 w, non-inductive, wire-wound plaque.	1	(W3)	*	*
R35	3Z4805-2	RESISTOR: 5 ohms; 40 w, non-inductive, wire-wound plaque.	3	(W3)	*	*
R36, R37, R38, R39, R40, R41	3Z4810-2	RESISTOR: 10 ohms; 40 w, wire-wound, non-inductive plaque.	8	(W3)	*	*
R42, R43	3Z4805-2	RESISTOR: same as R35.				
R44	3Z4810-2	RESISTOR: same as R36.				
R45, R46, R47	3Z4825-1	RESISTOR: 25 ohms; 40 w, non-inductive, wire-wound plaque.	3	(W3)	*	*
R48, R49	3Z4900-5	RESISTOR: 100 ohms; 40 w, non-inductive, wire-wound plaque.	2	(W3)	*	*
R50	3Z5000-1	RESISTOR: 200 ohms; 40 w, non-inductive wire-wound plaque.	1	(W3)	*	*
R51	3Z5350-4	RESISTOR: 500 ohms; 40 w, non-inductive, wire-wound plaque.	1	(W3)	*	*
R52	3Z5440-1	RESISTOR: 4,000 ohms; 40 w, non-inductive, wire-wound plaque, tapped.	1	(W3)	*	*
R53	3Z4810-2	RESISTOR: same as R36.				
R54	3Z5450-5	RESISTOR: 5,000 ohms; 20 w, wire-wound.	2	(W3)	*	*
R55	3Z6005-79	RESISTOR: 50 ohms; 2 w, wire-wound.	1	BW2 (I2)	*	*
R56	3Z6001-29	RESISTOR: 10 ohms; 2 w, wire-wound.	1	BW2 (I2)	*	*

*Indicates stock available.
†Parts not stocked in station or region stock are carried in depot stock.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A (cont'd)

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock†	Region Stock†
R57, R58	3Z5995-29	RESISTOR: 5 ohms; 2 w, wire-wound.	2	BW2 (I2)	*	*
R59	3Z6006C1-2	RESISTOR: 63 ohms; 2 w, wire-wound.	1	BW2 (I2)	*	*
R60	3Z6610-155	RESISTOR: 10,000 ohms; 2 w, wire-wound.	3	F2 (I2)	*	*
R61	3Z6630-63	RESISTOR: 30,000 ohms; 2 w, wire-wound.	1	F2 (I2)	*	*
R62	3Z6610-155	RESISTOR: same as R60.				
R63	3Z6680-15	RESISTOR: 80,000 ohms; 2 w, wire-wound.	2	F2 (I2)	*	*
R64	3Z6610-155	RESISTOR: same as R60.				
R65	3Z6680-15	RESISTOR: same as R63.				
R66	3Z5450-5	RESISTOR: same as R54.				
R67, R68	3Z6801-78	RESISTOR: same as R1.				
S0-V1, S0-V2	2Z8763	SOCKET: tube; 5 prong; ultra-steatite, wafer.	5	225MED (J4)		*
S0-V3, S0-V4, S0-V5, S0-V6	2Z8759.3	SOCKET: tube; 4 prong, steatite, 50 w, type.	6	211S (J4)		*
S0-V7, S0-V8, S0-V9	2Z8763	SOCKET: same as S0-V1.				
S0-V10, S0-V11	2Z8759.4	SOCKET: tube; 4 prong, steatite, shell type.	2	209S (J4)		*
S0-V12, S0-V13	2Z8759.3	SOCKET: same as S0-V3.				
S0-V14, S0-V15, S0-V16, S0-V17, S0-V18, S0-V19, S0-V20	2Z8678.29	SOCKET: tube; octal, ultra-steatite.	7	228 (J4)		*
S1	3Z9825-90.3	SWITCH: double pole, double throw, rotary; wafer; to pole, 2 position; 3 amp, 500 v, ceramic.	1	B-167-6A (R18)		*
S2	3ZK9851-3	SWITCH: toggle; 1 pole, 2 position; 10 amp, 125 v.	1	1313 (P2)	*	*
S3	3Z9851	SWITCH: toggle; 1 pole, 1 position; 10 amp, 125 v.	2	1311 (P2)		
S4	3Z9865	SWITCH: toggle; 4 circuit, 2 position; 10 amp, 125 v, shorting.	1	289739 (G3)	*	*
S5	3Z9851	SWITCH: same as S3.				

*Indicates stock available.
†Parts not stocked in station or region stock are carried in depot stock.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A (cont'd)

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock†	Region Stock†
S6	3Z9825-90	SWITCH: rotary; single pole, double throw; 3 amp, 500 v; ceramic wafer.	1	A-167-7 (R18)		*
S7	3Z9825-90.1	SWITCH: rotary; 2 pole, 4 position, 3 amp, 500 v, ceramic wafer.	1	B-168-6 (R18)		*
S8	3Z9825-90.2	SWITCH: rotary; 2 pole, 10 position; 3 amp, 500 v; 2 wafer, ceramic.	1	B-168-7 (R18)		*
S9	3Z9825-90.4	SWITCH: rotary; 3 pole, 2 position, 3 amp, 500 v, 2 wafer, ceramic.	1	B-168-8 (R18)		*
S10	3Z9558-7	SWITCH: rotary; 1 pole, 1 position; 10 amp.	2	MGZL (S18)		*
S11		SWITCH: same as S10.				
TH1	2Z9489.23	THERMOSTAT: open 70 F; close 50 F.	1	C4351-17 (S7)		*
TH2	2Z9489.8	THERMOSTAT: open 60 F; close 73 F.	1	C4351-17 (S7)		*
TH3	2Z9489.8	THERMOSTAT: open 50 F; close 63 F.	1	C4351-17 (S7)		*
TH4	2Z9489.10	THERMOSTAT: open 160 F; close 147 F.	1	C4351-17 (S7)		*
T1	2Z9607-7	TRANSFORMER: plate; primary: 115-230 v, 60 cps; secondary: 3,000 v, center tap, at 0.7 amp, d-c.	1	466-T1 (S28)		*
T2	2Z9611.92	TRANSFORMER: filament; primary: 115 v, 60 cps; secondary: 5 v, center tap at 20 amp.	1	466-T2 (S28)		*
T3	2Z9611.93	TRANSFORMER: filament; primary: 115 v, 60 cps; secondary: 2.5 v, center tap at 12.5 amp.	1	466-T3 (S28)		*
T4	2Z9607-8	TRANSFORMER: plate; primary: 115-230 v, 60 cps; secondary: 1,250 v, center tap at 0.5 amp.	1	466-T4 (S28)		*
T5	2Z9611.94	TRANSFORMER: filament; primary: 115 v, 60 cps; secondary: No. 1 6.3 v at 7.5 amp; secondary: No. 2 10 v at 8.8 amp, center tap; secondary: No. 3 10 v at 8.8 amp, center tap.	1	466-T5 (S28)		*
T6	2Z9608-10	TRANSFORMER: power; primary: 115-230 v, 60 cps; secondary: 100-120-140 v at 0.6 amp.	1	466-T6 (S28)		*
T7	2Z9631.70	TRANSFORMER: audio; 1 primary, 2 h, 300 ohms, d-c resistance, plate to plate; secondary: resistance 1,800 ohms, d-c resistance, ratio 1 to 1 (½ second).	1	466-T7 (S28)		*
T8	2Z9633.12	TRANSFORMER: audio; driver, primary: 7,000 ohms, plate to plate, 60 ma d-c; secondary: 800 ohms, 25 va.	1	466-T8 (S28)		*
T9	2Z9634.25	TRANSFORMER: modulation; primary: class B, 9,000 ohms, 150 ma d-c; secondary; class C, 6,000 ohms, 300 ma d-c, 200 va.	1	466-T9 (S28)		*

*Indicates stock available.
†Parts not stocked in station or region stock are carried in depot stock.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A (cont'd)

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock†	Region Stock†
T10	2Z9621-25	TRANSFORMER: auto; 230 v, 60 cps, to 115 v at 250 va.	1	466-T10 (S28)		*
T12	2Z9631.69	TRANSFORMER: audio; line to push-pull grid; primary: 600 ohms, balance center tap; secondary: push-pull 100,-000 ohm grid.	1	466-T12 (S28)		*
V1, V2	2J807	TUBE: JAN 807.	5	807 (R2)	*	*
V3, V4, V5, V6	2J805	TUBE: JAN 805.	4	805 (R2)	*	*
V7, V8, V9	2J807	TUBE: same as V1.				
V10, V11	2J866A	TUBE: JAN 866A.	2	866A (N11)	*	*
V12	2J872A	TUBE: JAN 872A.	2	872A (N11)	*	*
V14, V15, V16, V17	2JVR-150-30	TUBE: JAN VR150-30.	4	VR-150-30 (R2)	*	*
V18, V19, V20	2J6H6GT	TUBE: JAN 6H6GT.	3	6H6GT (R7)	*	*
Fig. 6	2C7645A	REMOTE CONTROL UNIT.		RM-45-A (R5)		
C1R	3DB50-15	CAPACITOR: electrolytic; oil, 50 mfd, 100 v d-c working, 4 prong base, plug-in.	1	D0A (S5)	*	*
C2R	3DB200-2	CAPACITOR: electrolytic; oil, 200 mfd, 50 v d-c working, 4 prong plug-in.	1	D0A (S5)	*	*
C3R	3DB4-63	CAPACITOR: paper; oil, 4 mfd, 100 v, d-c working.	1	XDRHW1-4	*	*
X1R	3C335-6	CHOKE: power-supply filter; 2.5 h at 25 ma d-c; 1,600 v insulation.	1	466-X1R (S18)		*
CO1R	2Z7588-23/2	COIL: 20 v d-c, 12,000 ohms, d-c resistance.	1	BX14 (A37)		*
CON1R	2Z7588-23/1	CONTACTS: 1 amp; 48 v d-c.	1	BX14 (A37)	*	*
F1R	3Z1964	FUSE: cartridge: non-renewable; 1 amp; 250 v, type 4AG.	1	1091 (B9)	*	*
P1R	4C5491-E3	LAMP: pilot; 0.12-0.16 amp; 6 v.	1	DB-58 (A8)	*	*
P2R, P3R	4C5492-C	LAMP: pilot; 35 ma; 35 v.	2	DB-76 (A8)	*	*
M1R	3F891-25	METER: ma, a-c rectifier type; special scale; 1 ma full scale at 1,000 cps.	1	453-M3 (R5)		*
PG1R	6Z7591-15	RECEPTACLE: female; 2 wire; 10 amp, midget twist-lock, 1" diam.	1	7461 (H4)		

*Indicates stock available.
†Parts not stocked in station or region stock are carried in depot stock.

77. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTER BC-446-J AND REMOTE CONTROL UNIT RM-45-A (cont'd)

Ref. Symbol	Signal Corps Stock No.	Name of Part and Description	Quan. per Unit	Mfrs. Part and Code No.	Station Stock†	Region Stock†
S0-PG1R	6Z815	RECEPTACLE: male; 2 wire; 10 amp, twist-lock, midget, special.	1	7466 (H4)		*
E1R	2Z7588-23	RELAY: double pole, single throw, 1 normally open, 1 normally closed coil; 20 v d-c; contacts 1 amp, 48 v d-c.	1	BD-42 (A37)		
R1R	3Z6025-60	RESISTOR: 250 ohms, 25 w, wire-wound.	2	2-S (L5)	*	*
R2R	2Z7278-5	RESISTOR: potentiometer; 5-500 ohms, L taper, wire-wound.	1	P58 (R5)		*
R3R	3Z6250-4	RESISTOR: 2,500 ohms, 2 w, carbon.	1	F-2 (I2)		*
R4R	3Z6025-60	RESISTOR: same as R1R.				
R5R	3Z6010-116	RESISTOR: 100 ohms, 25 w, wire-wound.	1	2-S (L5)	*	*
S0-V1R, C1R, C2R	2Z8659-5	SOCKET: tube; 4 prong; bakelite, wafer.	3	M1P4 (A13)		*
S1R, S2R	3Z9851	SWITCH: toggle; single pole, double throw; 10 amp at 125 v.	2	1311 (P18)	*	*
T1R	2Z9613.97	TRANSFORMER: power; primary: 115 v, 60 cps; secondary No. 1: 5 v, 3 amp; secondary No. 2: 220 v, 0.225 amp center tap.	1	466-T1R (S28)		*
T2R	2Z9631.79	TRANSFORMER: audio; microphone to line; primary: 50 ohms at 0.15 amp d-c; secondary: 600 ohms center tap balanced.	1	466-T2R (S28)		*
V1R	2J5Z3	TUBE: JAN 5Z3.	1	5Z3 (R2)	*	*

*Indicates stock available.
†Parts not stocked in station or region stock are carried in depot stock.

78. LIST OF MANUFACTURERS

Code	Manufacturer's Name
A5	Allen-Bradley Co., Milwaukee, Wis.
A8	Automatic Electric Sales Corp., Chicago, Ill.
A13	American Phenolic Corp., Chicago, Ill.
A37	Allied Control Co., New York City, N. Y.
B6	H. O. Boehme Inc., New York City, N. Y.
B9	Bussman Mfg. Co., St. Louis, Mo.
C2	Allen D. Cardwell Mfg. Corp., Brooklyn, N. Y.
C4	Centralab, Milwaukee, Wis.
C7	Chase and Shawmut Co., Newberry, Mass.
C10	Clarostat Mfg. Co., Inc., Brooklyn, N. Y.
C16	Cramer, R. W. The Co., Centerbrook, Conn.
G2	General Controls Co., San Francisco, Calif.
G3	General Electric Co., Schenectady, N. Y.
H4	Harvey Hubbell Inc., Bridgeport, Conn.
H6	Heinemann Circuit Breaker Co., Trenton, N. J.
I2	International Resistance Co., Phila., Pa.
I4	International Telephone and Radio Mfg. Corp., New York City, N. Y.
I6	Isolantite Inc., New York City, N. Y.
J2	Jefferson Union Co., New York City, N. Y.
J4	Johnson, E. E. Co., Waseca, Minn.
K3	Kenyon Transformer Co., Inc., New York City, N. Y.
L3	Littelfuse Lab., Chicago, Ill.
L4	Langevin Co., Inc. The, New York City, N. Y.
L5	Lectrohm Inc., Cicero, Ill.
M4	Millen, James Mfg. Co., Inc., Malden, Mass.
N1	National Co., Malden, Mass.
N11	National Union Radio Corp., Newark, N. J.
O4	Owens-Corning Fiberglass Corp., Toledo, Ohio
O5	Owens Illinois Glass Co., Toledo, Ohio
P2	Pass & Seymour Inc., Syracuse, N. Y.
P18	Pierce & Seymour
P28	Price Bros. Co., Frederick, Md.
R2	RCA Mfg. Co., Camden, N. J.
R5	Radio Receptor Co., Inc., New York City, N. Y.
R7	Raytheon Production Corp., Newton, Mass.
R9	Robbins & Myers, Inc., Springfield, Ohio
R18	Radio Switches Inc., West New York, N. J.
S5	Solar Mfg. Corp., Bayonne, N. J.
S6	Speer Resistor Corp., St. Mary's, Pa.
S7	Spencer Thermostat Co., Attleboro, Mass.
S12	Stromberg-Carlson Telephone Mfg. Co., Rochester, N. Y.
S13	Struthers Dunn Inc., Phila., Pa.
S18	Superior Electric Co., Bristol, Conn.
S19	Sylvania Electric Products, Inc., Emporium, Pa.
S28	Super Elec. Prod. Co., Newark, N. J.
T4	Thordarson Electric Mfg. Co., Chicago, Ill.
T5	Torrington Co., Torrington, Conn.
V2	United Electronics Co., Newark, N. J.
W1	Weage Electric Co.
W3	Ward-Leonard Electric Co., Mt. Vernon, N. Y.
W5	Western Electric Co., New York City, N. Y.
W6	Western Electric Instrument Corp., Newark, N. J.
W11	Worthington Pump & Machine Corp., Harrison, N. J.

79. RUNNING SPARES

Running spares are for initial use only and are not to be requisitioned as a kit or group.

Quan	Item	To replace part No.
4	Capacitor, mica	C1, C2, C4, C6, C8, C12, C13, C65
1	Capacitor, mica	C3, C7
1	Capacitor, mica	C11
1	Capacitor, mica	C14,
5	Capacitor, mica	C15, C16, C41, C42, C46, C47, C52, C53, C57, C58
2	Capacitor, mica	C18, C31, C36
2	Capacitor, mica	C19, C20, C32, C37
2	Capacitor, mica	C33, C34, C38, C39
4	Capacitor, mica	C43, C44, C48, C49,
2	Capacitor, mica	C54, C55, C59, C60
1	Capacitor, mica	C45, C50, C56, C61
		C62
1	Capacitor, mica	C63
1	Capacitor, mica	C64
1	Capacitor, mica	C66
1	Capacitor, mica	C67, C68
2	Capacitor, mica	C71, C72, C73
1	Capacitor, paper, oil	C22, C23
1	Capacitor, paper, oil	C24, C25
2	Capacitor, paper, oil	C26, C27, C28, C29
1	Capacitor, paper, oil	C69
1	Capacitor, paper, oil	C70
4	Sets of spare relay contacts	E4, E6
2	Spare relay coil	E4, E6
4	Sets of spare relay contacts	E7, E9
2	Spare relay coil	E7, E9
2	Sets of spare relay contacts	E10
1	Spare relay coil	E10
2	Sets of spare relay contacts	E11
1	Spare relay coil	E11
60	Fuse link	F1, F2, F5, F6, F14, F15
20	Fuse link	F3, F4
40	Fuse link	F7, F8, F11, F12
60	Fuse link	F7, F8, F11, F12, F14, F15
20	Fuse	F9, F10
10	Fuse	F13
1	Heater resistor	H5
1	Meter, dc	M1
1	Meter, ac	M2
12	Pilot lamps	P1, P2
2	Resistor	R1, R67, R68

79. RUNNING SPARES (cont'd)

Quan	Item	To replace part No.
1	Resistor	R2
2	Resistor	R3, R26, R27
1	Resistor	R4
1	Resistor	R5
1	Resistor	R6
1	Resistor	R7, R8
1	Resistor	R9, R10
2	Resistor	R11, R12, R13
1	Resistor	R14, R16
1	Resistor	R15
1	Resistor	R17
1	Resistor	R18
1	Resistor	R19, R30
2	Resistor	R20, R21, R22, R23
1	Resistor	R24
1	Resistor	R25
1	Resistor	R28
1	Dual potentiometer	R29
1	Dual potentiometer	R31
1	Resistor	R32, R33
1	Resistor	R34
2	Resistor	R35, R42, R43
4	Resistor	R36, R37, R38, R39, R40, R41, R44, R53
1	Resistor	R54, R66
1	Resistor	R55
1	Resistor	R56
1	Resistor	R57, R58
1	Resistor	R59
2	Resistor	R60, R62, R64
1	Resistor	R61
1	Resistor	R63, R65
2	Resistor, L pad, shunt arm	R45, R46, R47
1	Resistor, L pad, shunt arm	R48, R49
1	Resistor, L pad, shunt arm	R50
1	Resistor, L pad, shunt arm	R51
1	Resistor, L pad, shunt arm	R52
4	Dust filter (air intake)	
4	Dust filter (air outlet)	

80. EXPLANATION OF SYMBOLS

Following is a list of symbols which appear on illustrations other than the functional and schematic diagrams. Explanation of symbols for electrical parts (not listed here) is given on the respective functional and schematic diagrams of components.

ACTUATOR
- AC1 — To lock knob K6, K7, K8, K9, K10

BLOCK
- BL2 — To lock voice gain control KD2

BRACKETS
- BRA5 — Fuse and relay panel mounting
- BRA7 — Power relay panel mounting
- BRA18 — Goniometer bottom mounting
- BRA26 — To mount terminal board TB3 (right side)
- BRA27 — To mount tube heaters H1 and H2
- BRA49 — To mount board MB8
- BRA58 — To hold air filter AF1 (left and right sides)
- BRA59 — To hold air filter AF1 (front and rear)
- BRA60 — To mount goniometer at rear to top
- BRA61 — L pad (front)
- BRA62 — L pad (rear)
- BRA63 — L pad mounting
- BRA66 — To mount switch E3

BRUSHES
- BR1, BR2, BR3 — Goniometer primary sliding contact

BUSHING
- BU1 — Switch S1 actuator shaft

CHASSIS
- CHA1 — Voltage regulator tube chassis
- CHA2 — High voltage rectifier chassis
- CHA3 — Low voltage rectifier chassis
- CHA4 — A-f chassis
- CHA5 — R-f chassis
- CHA7 — To mount link circuit metering unit
- CHA10 — Relay rectifier chassis
- CHA11 — Left secondary meter rectifier chassis
- CHA12 — Right secondary meter rectifier chassis

CLAMPS
- CLA9 — To hold cable to fuse and relay panel
- CLA21 — To hold tube V5 plate lead

CLIPS
- CL4 — For tubes V3, V4, V5, V6, V10, V11, V12, V13
- CL5 — For tubes V1, V2, V7, V8, V9
- CL7 — To mount fuses F1, F2, F3, F4, F5, F6, F7, F8, F9, F10, F11, F12, F14, F15

COIL
- CO4 — Spare coil for relay E11

CONTACTS
- CON1 — Spare contacts for relay E4, E6
- CON4 — Spare contacts for relay E11

COUPLINGS
- CP1 — To driver capacitor C17, C30, C35, C40, C51
- CP2 — To operate capacitor C5, C10

COVERS
- CV1 — Main power switch
- CV2 — Goniometer panel

DIAL
- D1 — Goniometer dial

DIAL AND LOCK ASSEMBLY
- DDL1 — To operate capacitor C30, C35
- DDL2 — To operate capacitor C40, C51
- DDL4 — To operate inductor L3, L4
- DDL5 — To operate capacitor C10
- DDL6 — To operate capacitor C5

DIAL AND KNOB
- KD1 — Tone gain control
- KD2 — Voice gain control

FASTENER
- FA1 — To fasten side shield, SH11, SH12, SH13, SH14

FILTERS
- AF1 — Air exhaust
- AF2 — Air intake

FRAME
- FRA1 — Tuning chart window

80. EXPLANATION OF SYMBOLS (cont'd)

FUSES

- F1, F2 — Control circuit
- F3, F4 — Relay rectifier
- F5, F6 — Auxiliary plate rectifier
- F7, F8 — Filament supply
- F9, F10 — Keyer motor
- F11, F12 — Main plate rectifier
- F14, F15 — Blower motor

GEAR ASSEMBLY

- GR1 — Goniometer turning

HINGE

- HN1 — Goniometer hatch cover

INSULATORS

- IN1 — Feed-through on terminal board TB2
- IN5 — To support plate lead to tube V5
- IN14 — To mount inductor L15
- IN15 — Feed-through for capacitor C9
- IN16 — Modulation metering feed-through
- IN18 — To mount capacitor C9
- IN19 — To mount capacitor C9
- IN22 — To support lead from capacitor C10
- IN23 — To support quarter-phasing and p-a tank leads
- IN25 — To support lead from relay E2 to switch S7
- IN27 — To support leads to goniometer
- IN30 — Inductor L8 feed-through
- IN31 — Left goniometer primary feed-through
- IN35 — To mount capacitor C40
- IN38 — Inductor L9 feed-through
- IN39 — Right goniometer primary feed-through
- IN44 — Output feed-through
- IN45 — To mount L pad
- IN46 — Left goniometer meter rectifier feed-through
- IN47 — To mount link LK30
- IN49 — Terminal support for reactor K3
- IN50 — Link circuit meter rectifier feed-through
- IN51 — Goniometer secondary feed-through
- IN52 — Goniometer primary feed-through
- IN53 — Right goniometer rectifier feed-through
- IN54 — To mount link LK31

INDICATOR

- IND1 — Goniometer dial indicator

KNOBS

- K1 — D-c meter switch
- K2 — A-c meter switch
- K3 — Link tuning switch
- K4 — Tone frequency switch
- K5 — Crystal switch
- K6 — Link circuit tuning
- K7 — Output coupling
- K8 — Intermediate p-a tuning
- K9 — P-a tuning
- K10 — Crystal tuning
- K11 — Goniometer turning
- K12 — Goniometer lock
- K13 — Left primary tuning
- K14 — Left secondary tuning
- K15 — Right primary tuning
- K16 — Left secondary tuning

LINKS

- LK4 — Tube heater connector
- LK8, LK9, LK10, LK11 — Quarter-phasing capacitor connector
- LK24 — L pad cennector
- LK25 — L pad insertion connector
- LK26 — Transformer T6 connector
- LK30 — Shorting link for left secondary meter rectifier
- LK31 — Shorting link for right secondary meter rectifier

LUG

- LG1 — Connections to relay E7, E9

MOUNTING BOARD ASSEMBLIES

- MB7 — To mount capacitor C62, C63, C64
- MB8 — To mount capacitor C71 and resistor R60, R61
- MB9 — To mount capacitor C65 and fuse F13
- MB10 — Left secondary meter rectifier resistor and capacitor mounting board
- MB11 — Right secondary meter rectifier resistor and capacitor mounting board

PAN

- PAN1 — Keyer oil drip pan

PANELS

- PL1 — To mount socket SO-V9 and associated parts
- PL2 — To mount socket SO-V7, SO-V8 and associated parts
- PL4 — Board for mounting fuses and relays
- PL6 — To mount control switches and pilots
- PL7 — Mounting panel for inductor L2
- PL8 — Mounting panel for inductor L1
- PL9 — Meter and control unit front panel
- PL10 — Goniometer front panel
- PL11 — Left goniometer tuning panel
- PL12 — Right goniometer tuning panel
- PL13 — L pad panel
- PL14 — L pad insertion link panel

PLATES

- PLA3 — To mount inductor L4, L15
- PLA4 — To mount switch S8

RECTIFIERS

- SR1, SR2 — Bias and relay rectifier

RELAYS

- E7 — Remote control voice range switch-over
- E9 — Remote power control

SCREW

- LS2 — To lock knob and dial KD2

SHIELDS

- SH3 — Bottom front panel
- SH4 — Rear bottom skirt
- SH5 — Right side bottom skirt
- SH7 — Front bottom skirt
- SH8 — Transformer T9 heat shield
- SH9 — Link circuit meter rectifier
- SH10 — Transmitter top
- SH11 — Right and left side top shields
- SH12 — Right and left side bottom shields
- SH13 — Rear top shield
- SH14 — Rear bottom shield
- SH16 — Left secondary meter rectifier (end shield)
- SH18 — Right secondary meter rectifier (end shield)

SHIM

- SHM1 — To mount indicator IND1

SOCKETS

- SO-V1 thru SOV-20 — To mount tubes of corresponding symbol number

SPACERS

- SP1 — To mount indicator IND1
- SP2 — Fuse and relay panel mounting
- SP3 — Power relay panel mounting
- SP15 — Output ground connections
- SP17 — Ground connecting stud on left secondary meter rectifier
- SP20 — Ground connection on right secondary meter rectifier

STRIPS

- STR5 — A-f unit terminal strip
- STR9 — Meter rectifier inductor L12 terminal strip
- STR15 — L pad upper mounting strip (rear)
- STR17 — L pad lower mounting strip (rear)
- STR18 — Connector for capacitor C27, C28, C29

80. EXPLANATION OF SYMBOLS (cont'd)

STR19 Relay rectifier chassis interconnecting terminal strip
STR20 Left secondary meter rectifier terminal strip
STR21 Right secondary meter rectifier terminal strip

SUPPRESSORS
G3 Audio driver V8 plate
G4 Audio driver V9 plate

SWITCH
S4 Voltage regulator cut-out switch

TERMINAL BOARD ASSEMBLIES
TB1 To mount resistor R20, R21, R22, R23
TB2 High voltage rectifier chassis
TB3 Low voltage rectifier chassis
TB4 Audio line
TB5 R-f chassis
TB7 Keyer a-c terminal board
TB8 Meter and control unit rear terminal board
TB9 Meter and control unit left side terminal board
TB10 Relay rectifier terminal board

WASHER
WA4 To mount socket SO-V18

WINDOW
W2 Goniometer hatch cover

BRACKETS
BRA1R Shield and mounting bracket (right-side)
BRA2R Shield and mounting bracket (left-side)

CAPS
LC1R A-c line pilot
LC2R Voice pilot
LC3R Range pilot

COVER
CV1R Bottom cover

HOLDER
FH1R To mount fuse F1R

JACK
J1R Microphone Jack

KNOB
K1R Modulation level control

LOCKING MECHANISM ASSEMBLY
LM1R To lock top shield SH1R

METER
M1R Audio line level

PANEL
PL1R Front panel

RECEPTACLE, PILOT
PR1R To mount pilots, P1R, P2R, P3R

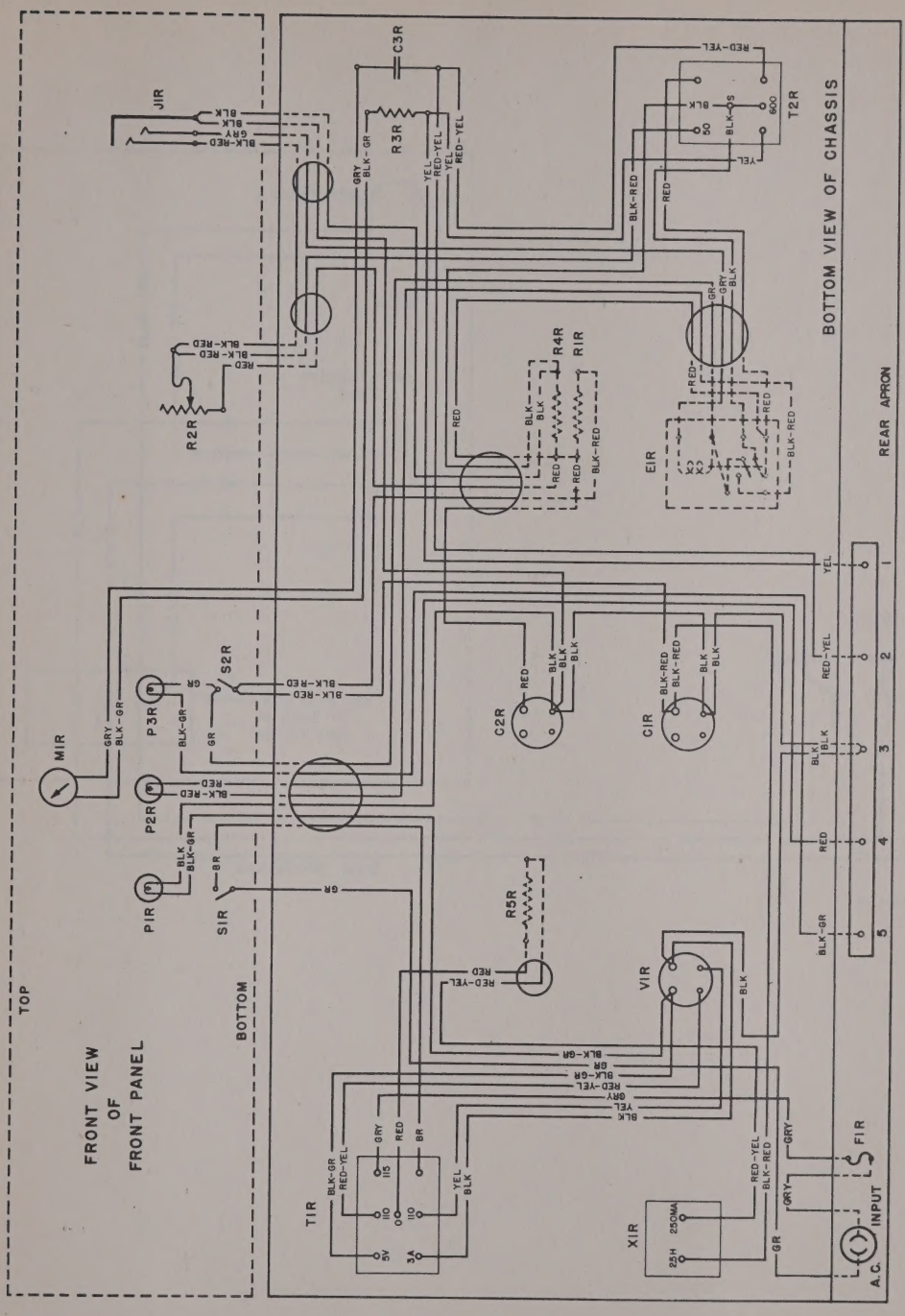
PLUG
PG1R A-c line

SHIELD
SH1R Top and rear cover

SOCKETS
SO-V1R To mount tube V1R
SO-C1R To mount capacitor C1R
SO-C2R To mount capacitor C2R
SO-PG1R A-c line

SWITCHES
S1R A-c line on-off
S2R Range on-off

STRIPS
STR1R To mount resistor R3R
STR2R Control lines terminal strip


TOP
FRONT VIEW OF FRONT PANEL
BOTTOM
BOTTOM VIEW OF CHASSIS
REAR APRON
J1R
C3R
R3R
T2R
R2R
R4R
R1R
E1R
M1R
P3R
P2R
P1R
S2R
S1R
C2R
C1R
R5R
V1R
T1R
X1R
F1R
A.C. INPUT
BLK
BLK-RED
GRY
BLK-GR
RED-YEL
YEL
RED
BLK-RED
BLK
GR
BR
RED
BLK-GR
BLK-RED
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RED
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BLK-RED
BLK
BLK
BLK

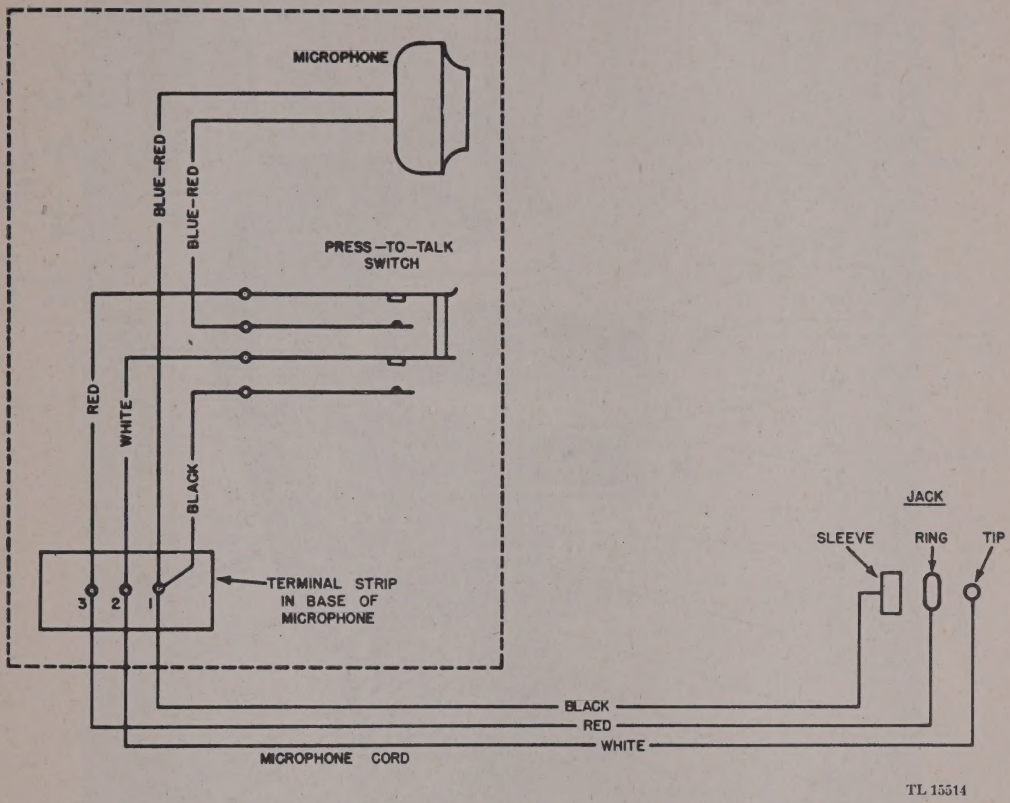


Figure 72. Microphone T-32, wiring diagram.

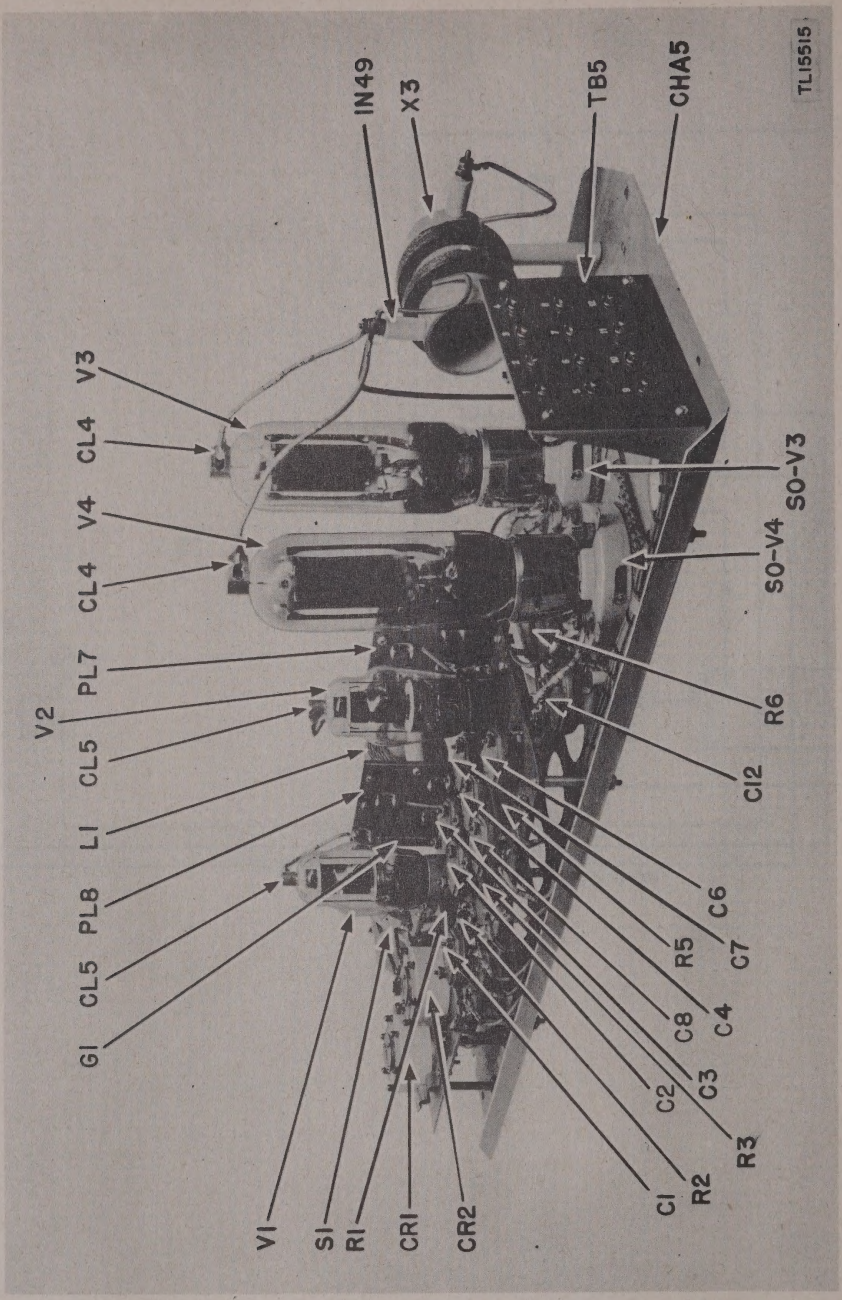
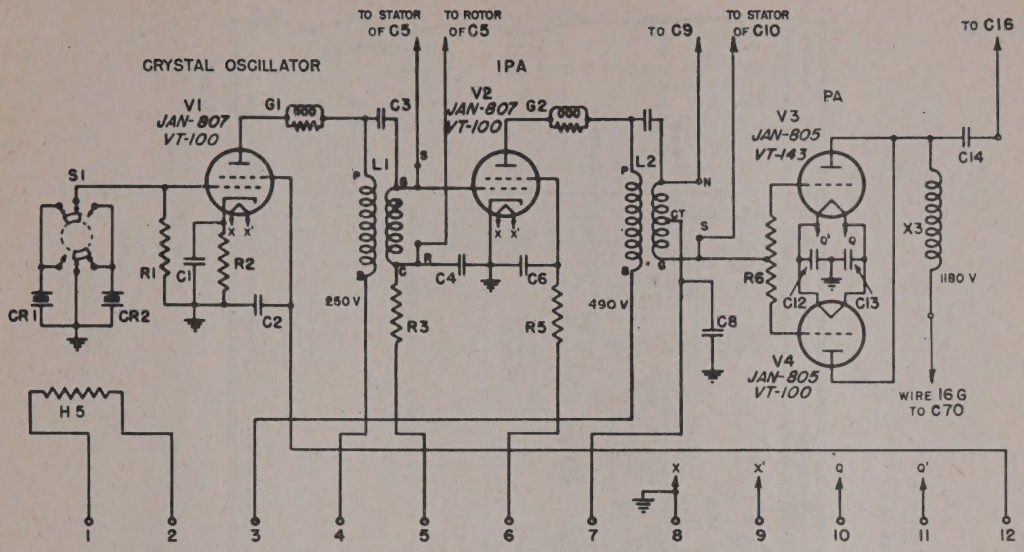


Figure 73. R-f chassis, top view.



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FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C1	Crystal oscillator cathode bypass (0.01 mfd, 600 v d-c working)
C2	Crystal oscillator screen bypass (0.01 mfd, 600 v d-c working)
C3	Intermediate p-a grid coupling (0.01 mfd, 1,200 v d-c working)
C4	Intermediate p-a grid bypass (0.01 mfd, 600 v d-c working)
C5	Crystal oscillator tuning (40-1,050 mmfd, variable)
C6	Intermediate p-a screen bypass (0.01 mfd, 600 v d-c working)
C8	P-a grid bypass (0.01 mfd, 600 v d-c working)
C9	P-a neutralization (16 mmfd)
C12	P-a filament bypass (0.01 mfd, 600 v d-c working)
C13	P-a filament bypass (0.01 mfd, 600 v d-c working)
C14	P-a to link coupling (0.004 mfd, 5,000 rms test)
C16	P-a tank (0.001 mfd, 8,000 rms test)
C70	Modulation meter M2 blocking (0.1 mfd, 2,000 v d-c working)

COILS

L1	Crystal oscillator tank (pri. 4.7 millihenries; sec. 800 microhenries)
L2	P-a coupling (pri. 4.7 millihenries; sec. 620 microhenries)
X3	P-a plate choke (15 millihenries)

CRYSTALS

CR1, CR2	Frequency control

HEATER

H5	Crystal (2,000 ohms, 4 w)

RESISTORS

R1	Crystal oscillator grid bias (1 megohm, 2 w)
R2	Crystal oscillator cathode bias (400 ohms, 2 w)
R3	Intermediate p-a grid bias (25,000 ohms, 2 w)
R5	Intermediate p-a screen dropping (3,000 ohms, 2 w)
R6	P-a grid suppressor (250 ohms, 40 w)

SUPPRESSORS

G1	Crystal oscillator
G2	Intermediate p-a plate

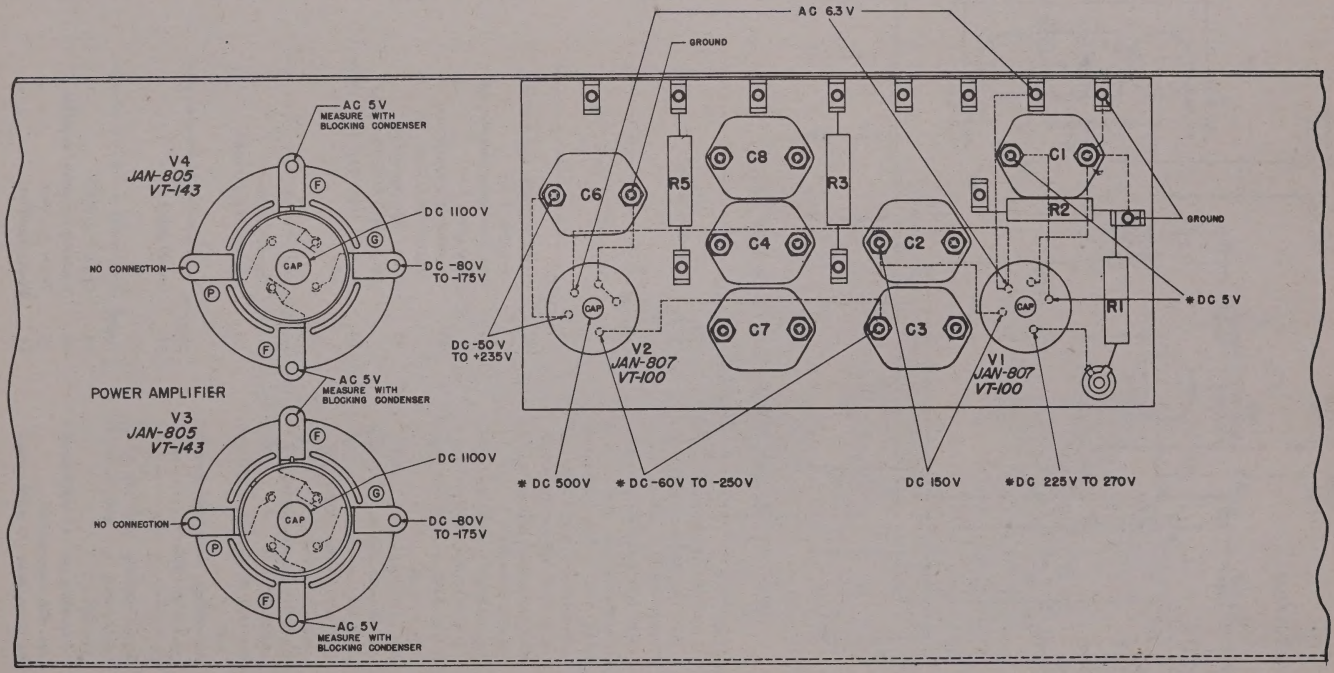
SWITCH

S1	Crystal selector

TUBES

V1	Crystal oscillator
V2	Intermediate power amplifier
V3	Power amplifier
V4	Power amplifier

Figure 74. R-f chassis, schematic diagram.



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* MEASURE WITH R F CHOKE IN SERIES WITH METER

Figure 75. R-f chassis, tube socket layout diagram.

Figure 75

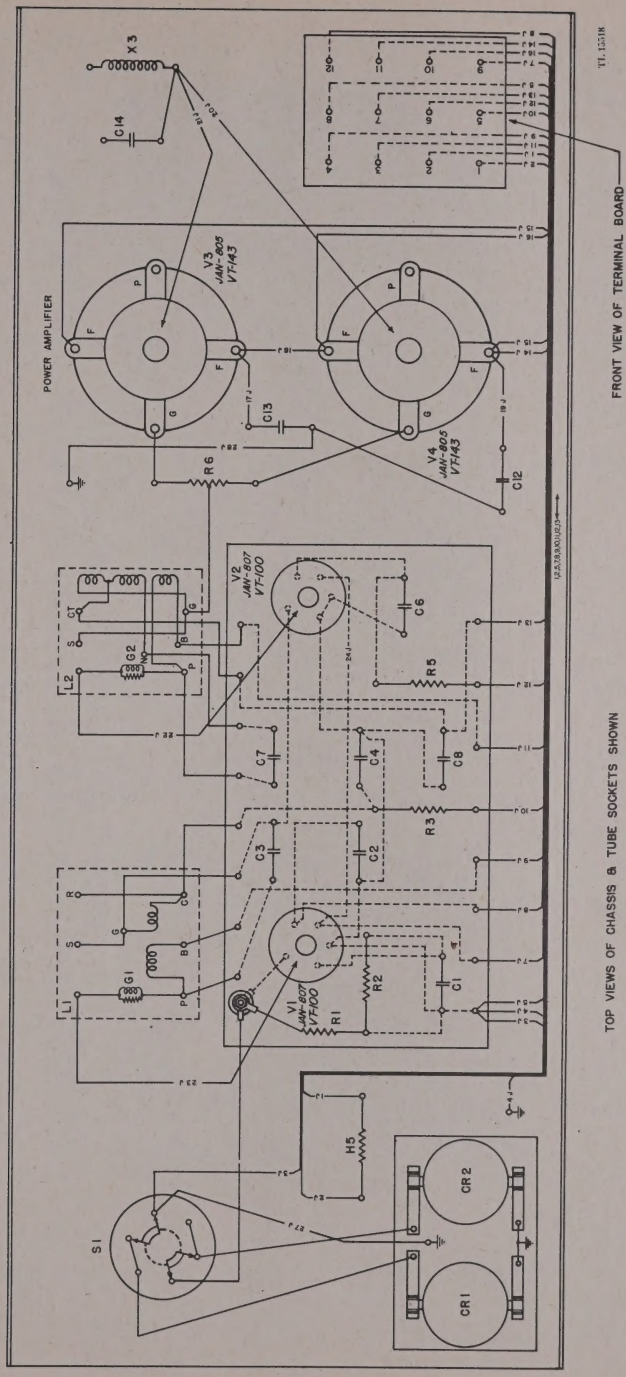


Figure 76. R-f chassis, wiring diagram.

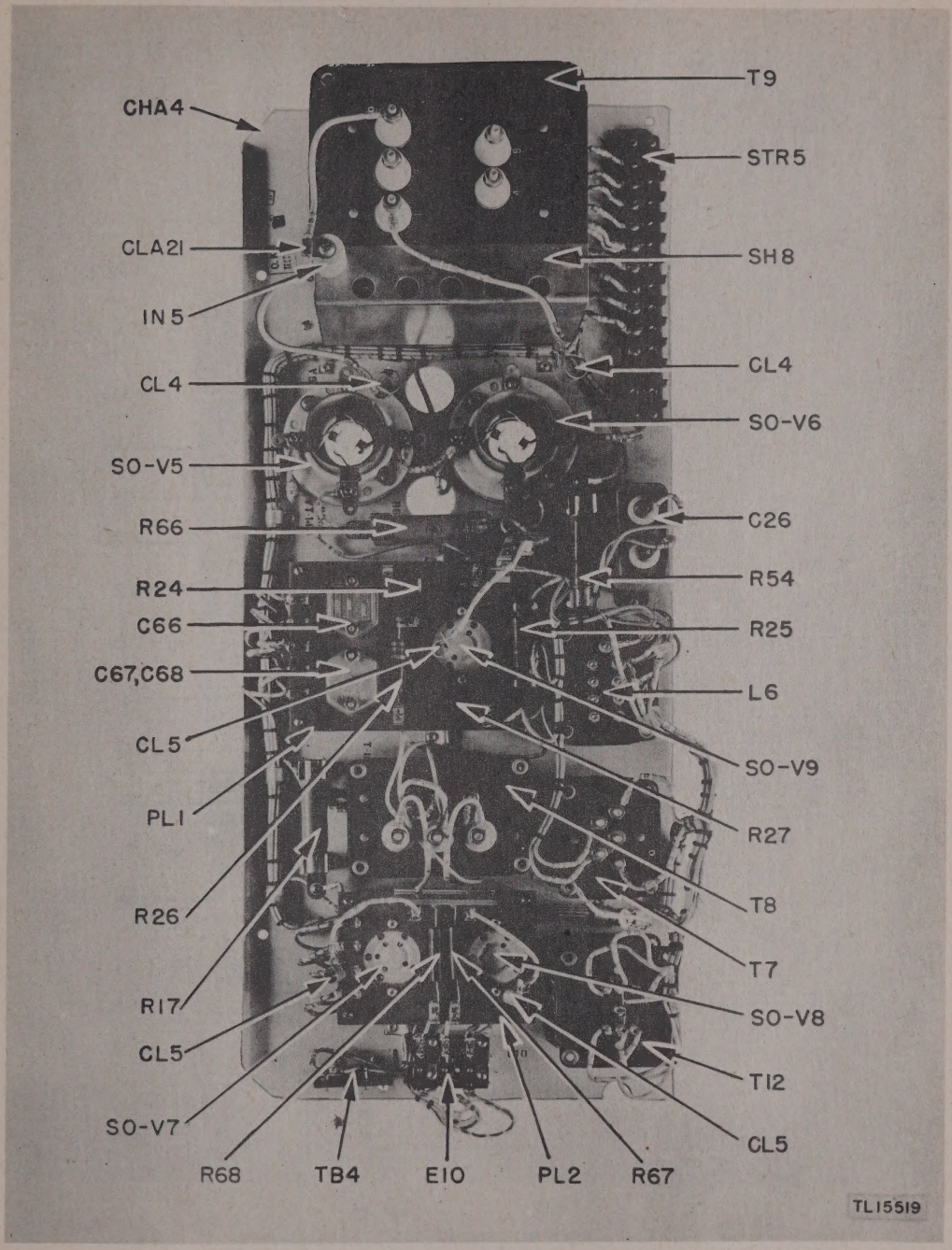


Figure 77. A-f chassis, top view.

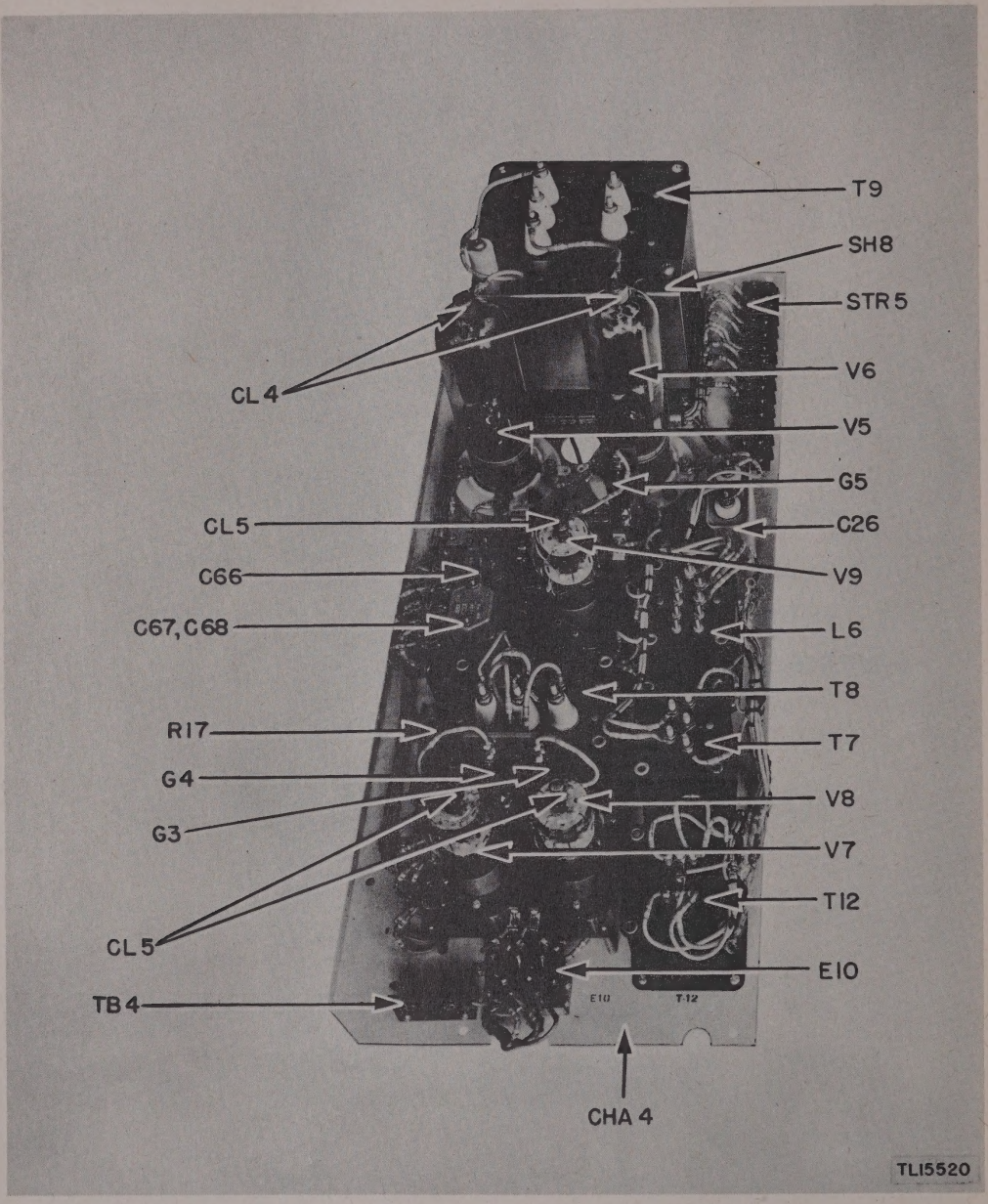


Figure 78. A-f chassis, top and front view.

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C26	Audio oscillator cathode bypass (4 mfd, 600 v d-c working)
C66	Audio oscillator tuning (0.022 mfd, 300 v d-c working)
C67	Audio oscillator tuning (0.0375 mfd, 300 v d-c working)
C68	Audio oscillator tuning (0.0375 mfd, 300 v d-c working)

COIL

L6	Tone oscillator tank (1 h)

RELAY

E10	Tone-voice switch-over

RESISTORS

R17	Audio amplifier cathode bias (200 ohms, 20 w)
R24	Audio oscillator grid limiter (100,000 ohms, 2 w)
R25	Audio oscillator cathode bias (1,000 ohms, 2 w)
R26, R27	Audio oscillator screen bleeder (25,000 ohms, 2 w)
R54	Audio oscillator plate dropping (5,000 ohms, 20 w)
R66	Modulator grid loading (5,000 ohms, 20 w)
R67	Driver grid (1 megohm, 2 w)
R68	Driver grid (1 megohm, 2 w)

SUPPRESSORS

G3	Audio driver V8
G4	Audio driver V7
G5	Tone oscillator

TRANSFORMERS

T7	Tone input
T8	Audio driver
T9	Modulation
T12	Voice input

TUBES

V5	Modulator
V6	Modulator
V7	Audio amplifier
V8	Audio amplifier
V9	Audio oscillator

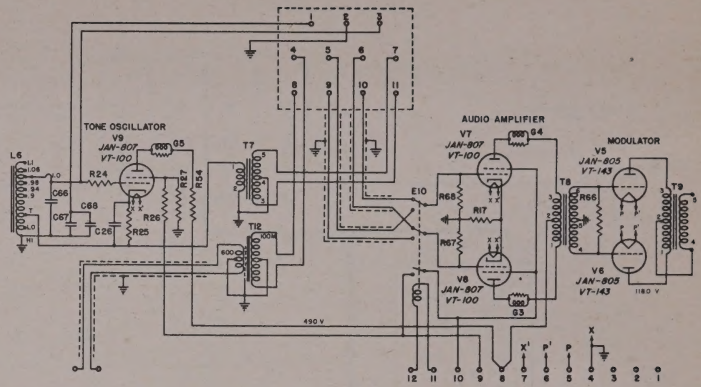


Figure 79 TL 15521

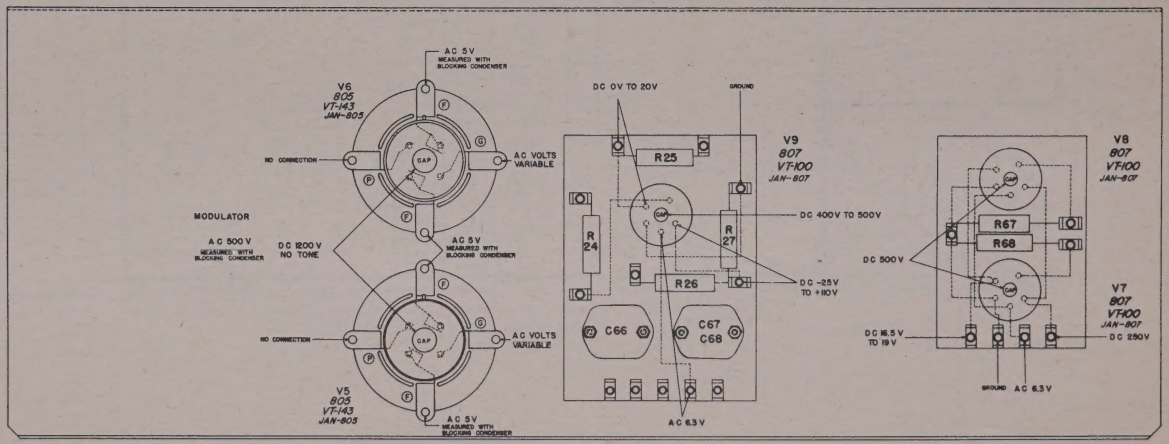


Figure 80

TL 15522

Figure 79. A-f chassis, schematic diagram.

Figure 80. A-f chassis, tube socket layout diagram.

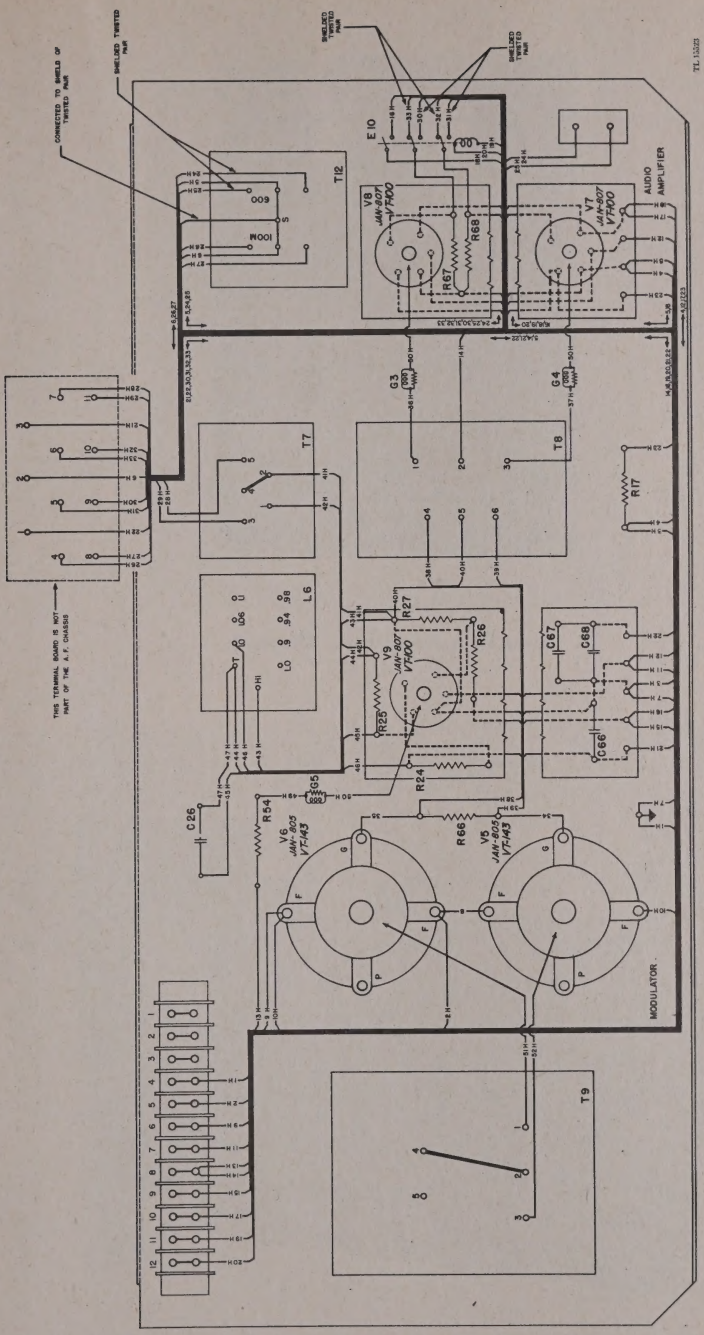


Figure 81. A-f chassis, wiring diagram.

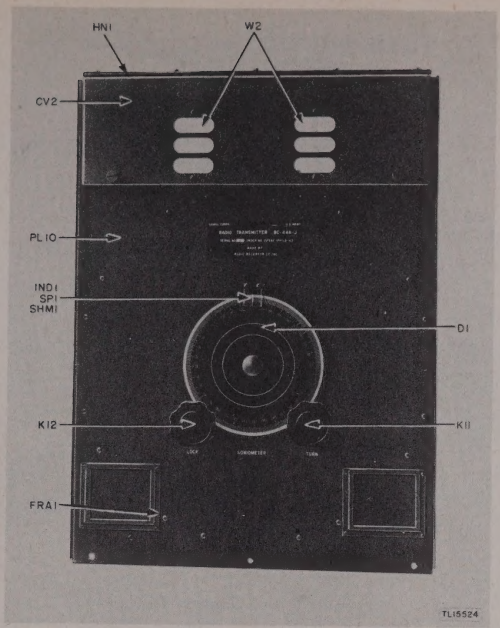


Figure 82. Goniometer, front panel.

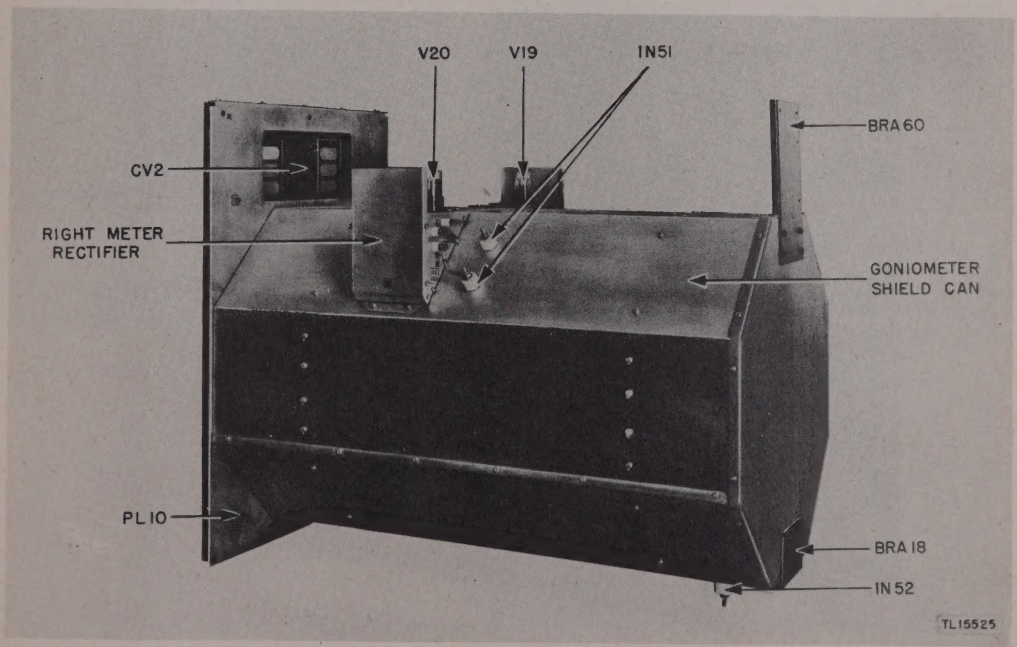


Figure 83. Goniometer in shield, rear and right side view.

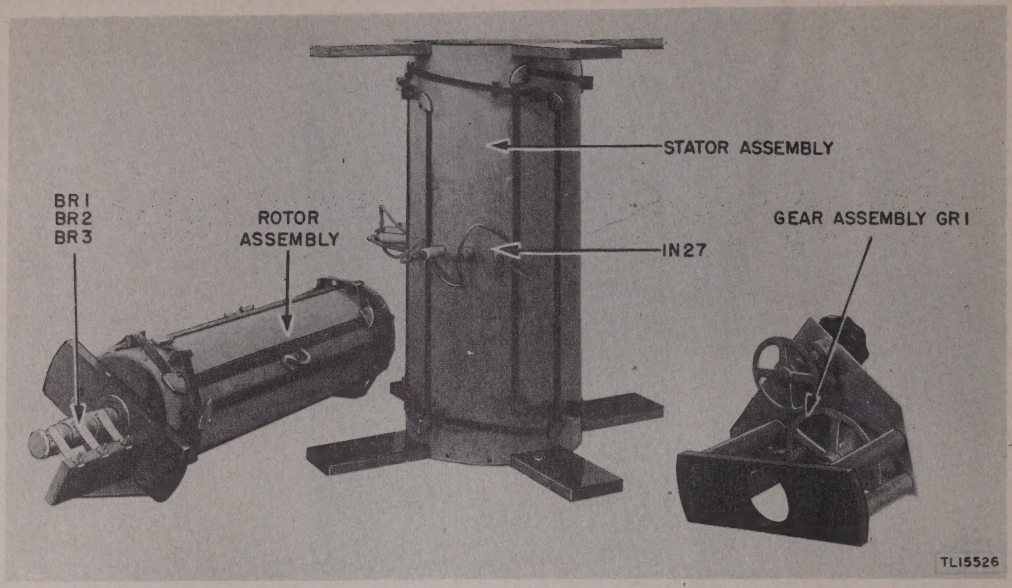


Figure 84. Goniometer, disassembled.

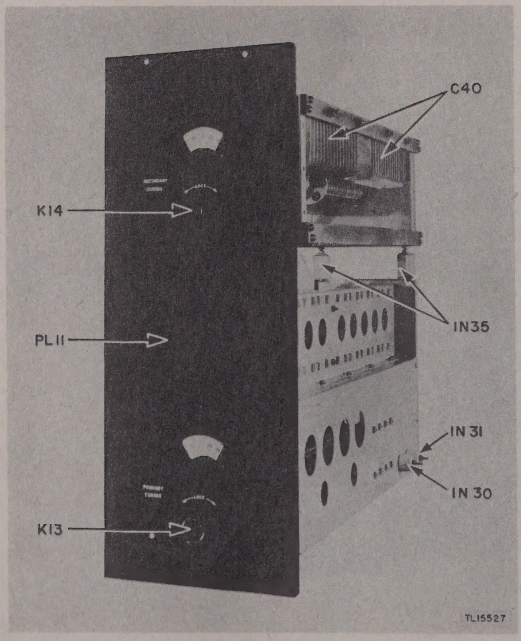


Figure 85. Left goniometer tuning unit, front and side view.

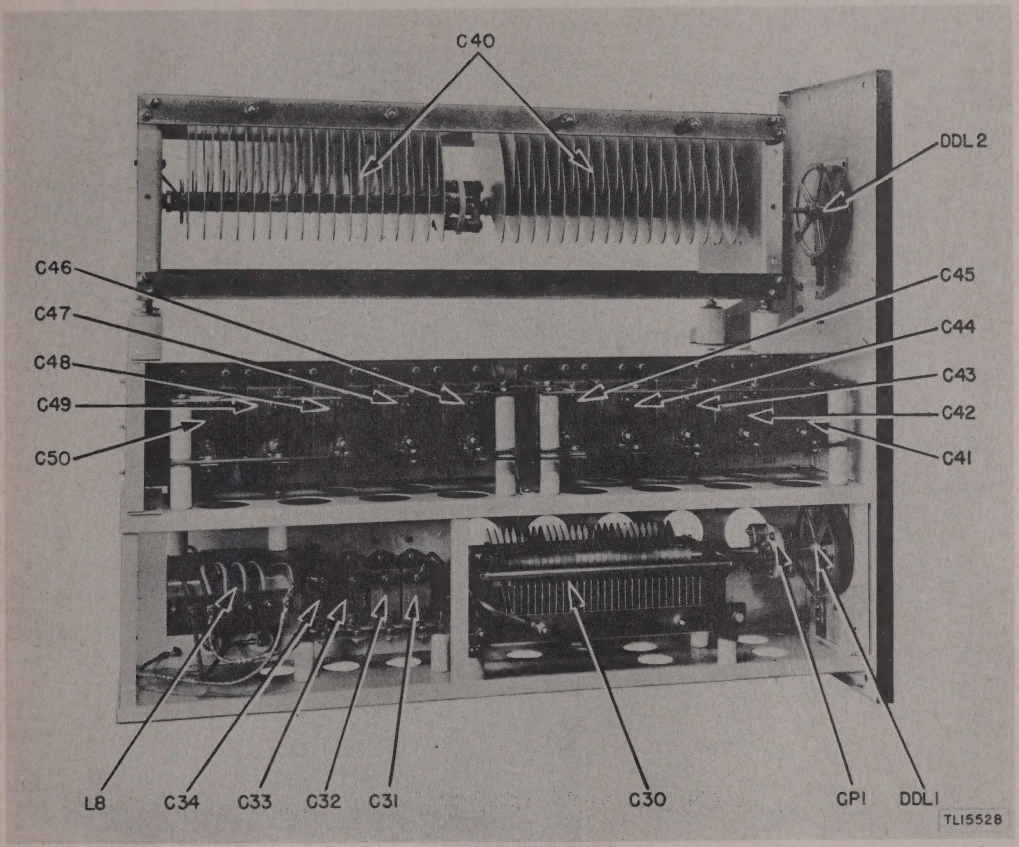


Figure 86. Left goniometer tuning unit, side view.

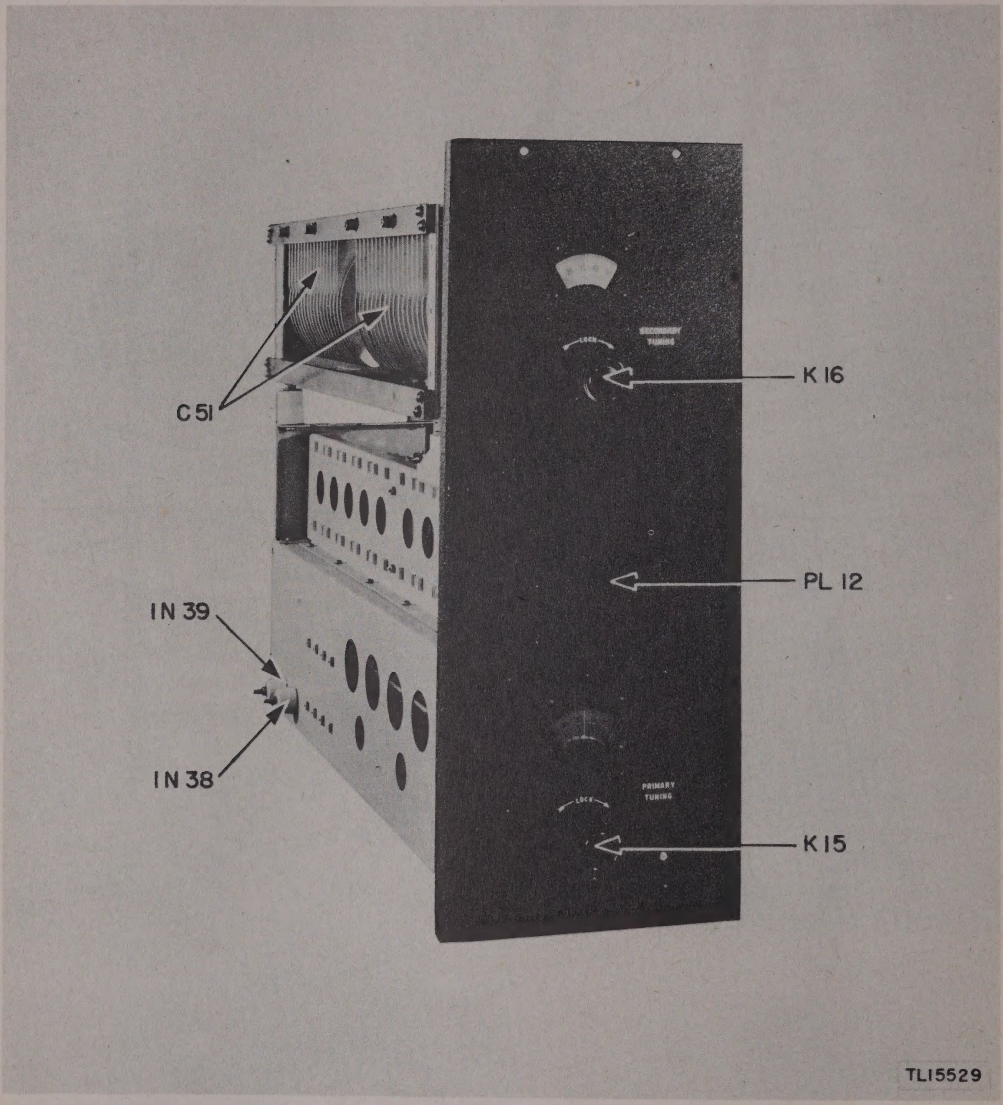


Figure 87. Right goniometer tuning unit, front and side view.

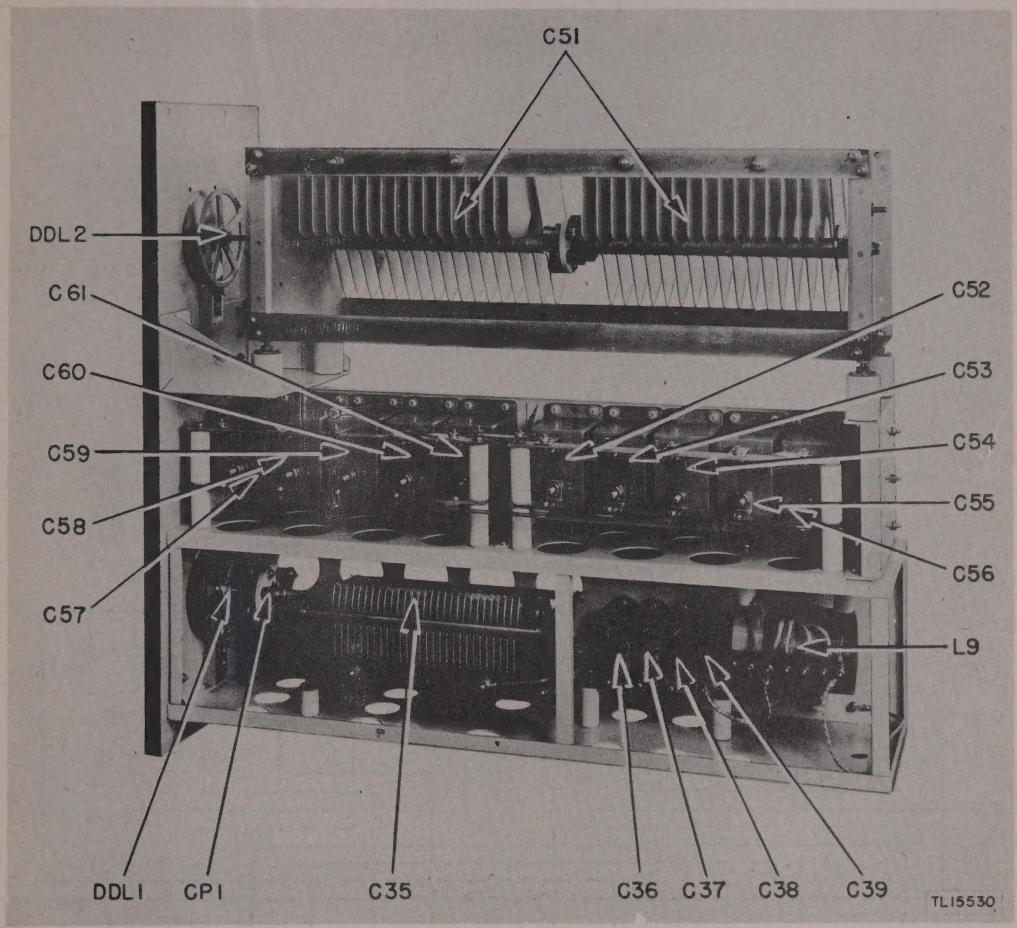


Figure 88. Right goniometer tuning unit, side view.

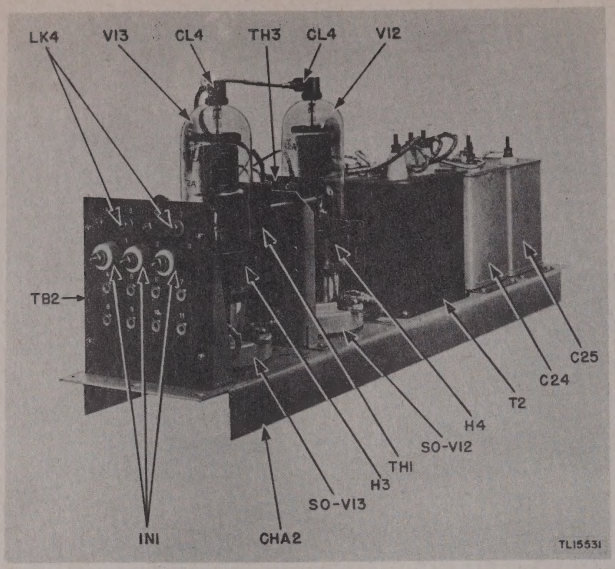
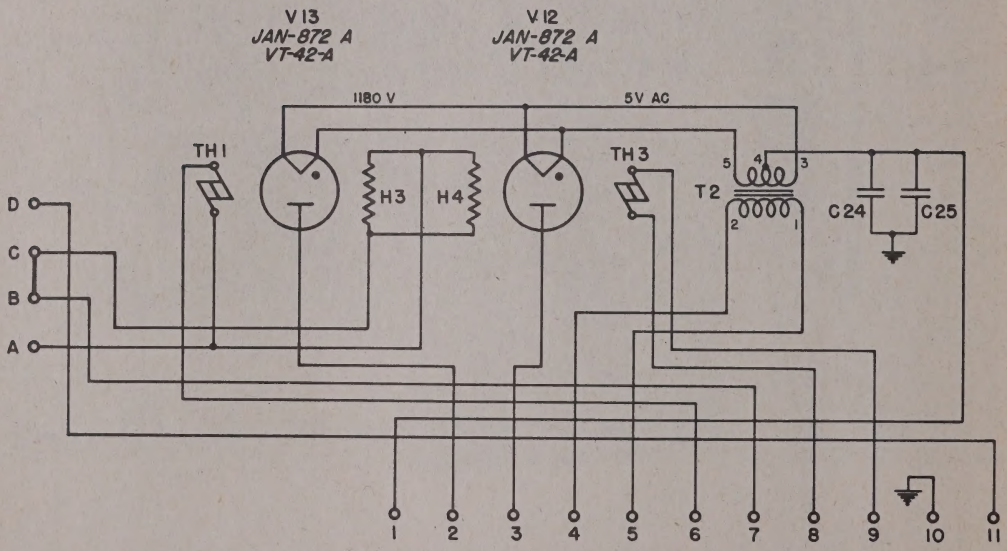


Figure 89. Main plate rectifier chassis, front and side view.



FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C24, C25 — Main plate rectifier filter (6 mfd, 2,000 v d-c working)

HEATERS

H3 — Tube V12 (100 w)

H4 — Tube V13 (100 w)

SWITCHES

TH1 — Tube heater thermostatic

TH3 — Under-temperature thermostatic

TRANSFORMER

T2 — Main plate rectifier filament (pri. 115 v; sec. 5 v)

TUBES

V12, V13 — Main plate rectifier

Figure 90. Main plate rectifier chassis, schematic diagram.

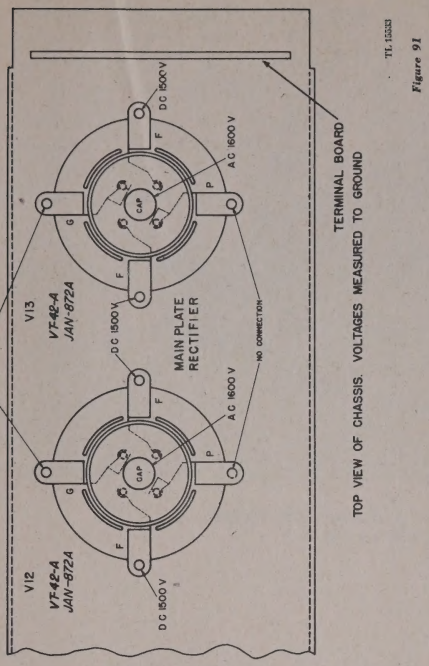


Figure 91

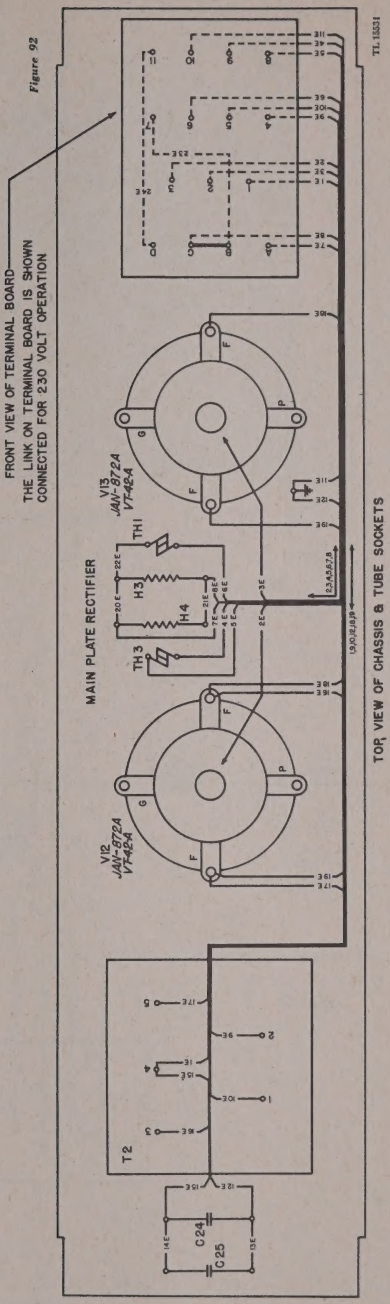


Figure 92

Figure 91. *Main plate rectifier chassis, tube socket layout diagram.*

Figure 92. *Main plate rectifier chassis, wiring diagram.*

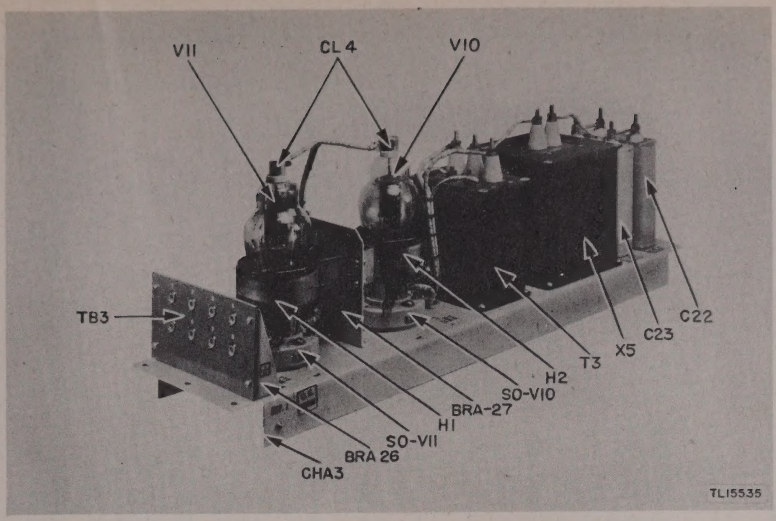
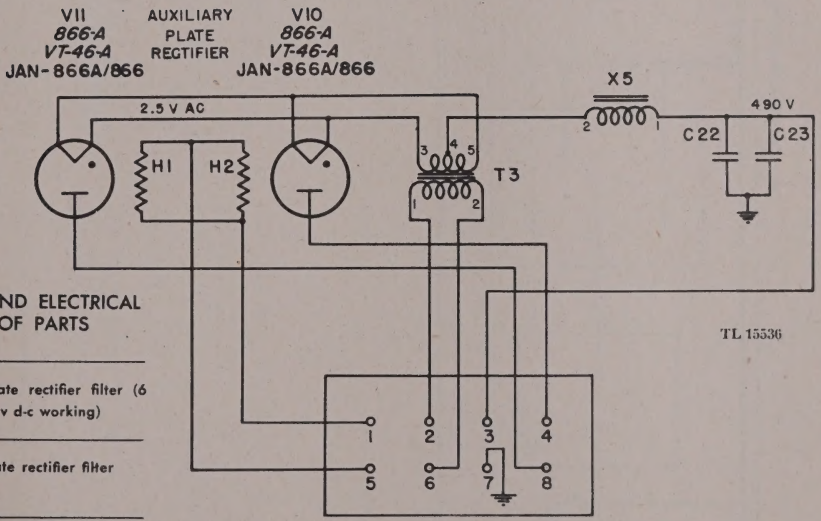


Figure 93. Auxiliary plate rectifier chassis, front and side view.



FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C22, C23 — Auxiliary plate rectifier filter (6 mfd, 1,000 v d-c working)

COIL

X5 — Auxiliary plate rectifier filter choke (8 h)

HEATERS

H1 — Tube V10 (100 w)

H2 — Tube V11 (100 w)

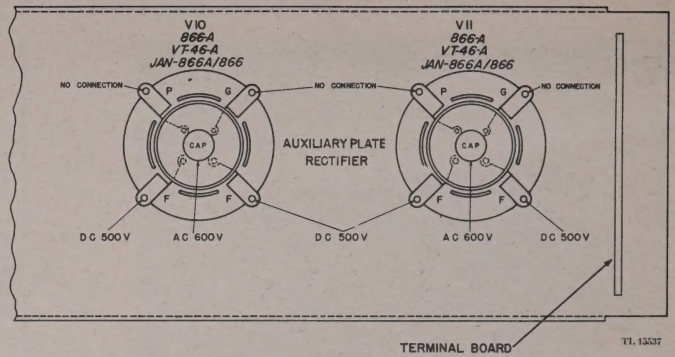
TRANSFORMER

T3 — Auxiliary plate rectifier filament (pri. 115 v; sec. 2.5 v)

TUBES

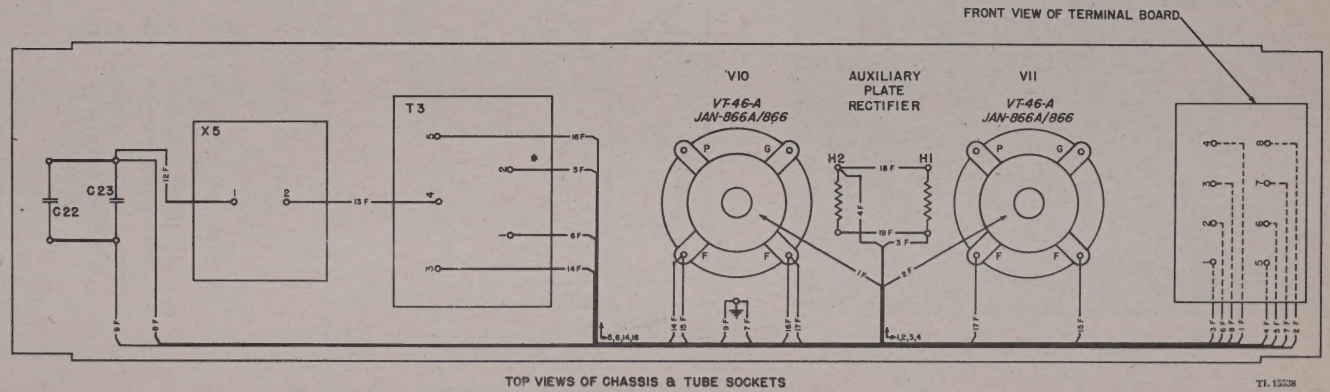
V10, V11 — Auxiliary plate rectifier

Figure 94. Auxiliary plate rectifier chassis, schematic diagram.



TOP VIEW OF CHASSIS, VOLTAGES MEASURED TO GROUND

Figure 95



TOP VIEWS OF CHASSIS & TUBE SOCKETS

Figure 96

Figure 95. Auxiliary plate rectifier chassis, tube socket layout diagram.

Figure 96. Auxiliary plate rectifier chassis, wiring diagram.

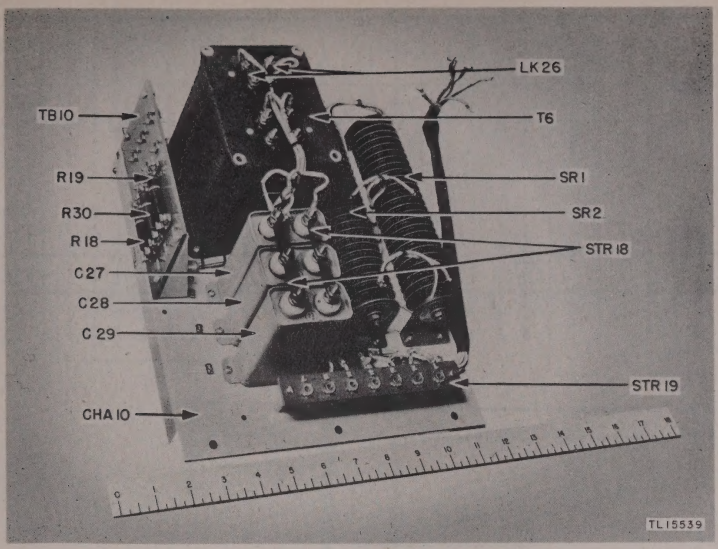
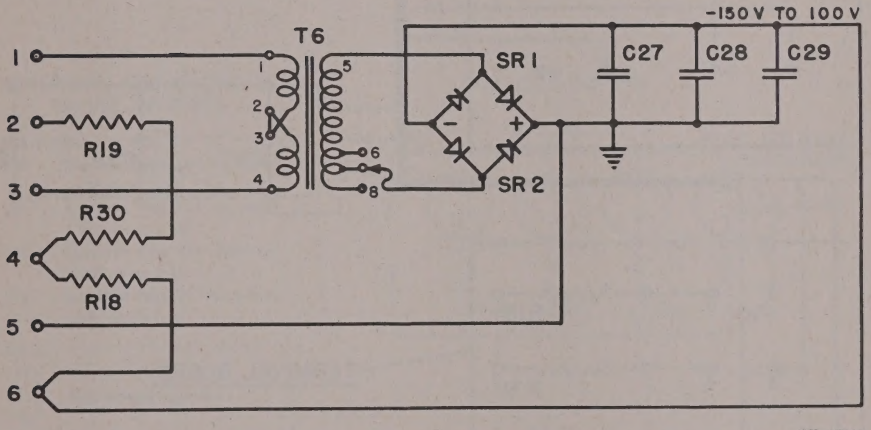


Figure 97



FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C27, C28, C29 — Relay rectifier filter (4 mfd, 600 v d-c working)

RESISTORS

R18 — Bias voltage regulator limiting (10,000 ohms, 2 w)
R19 — Bias isolator (50,000 ohms, 2 w)
R30 — Bias isolator (50,000 ohms, 2 w)

RECTIFIERS

SR1, SR2 — Bias and relay (¼ amp, 120 v d-c)

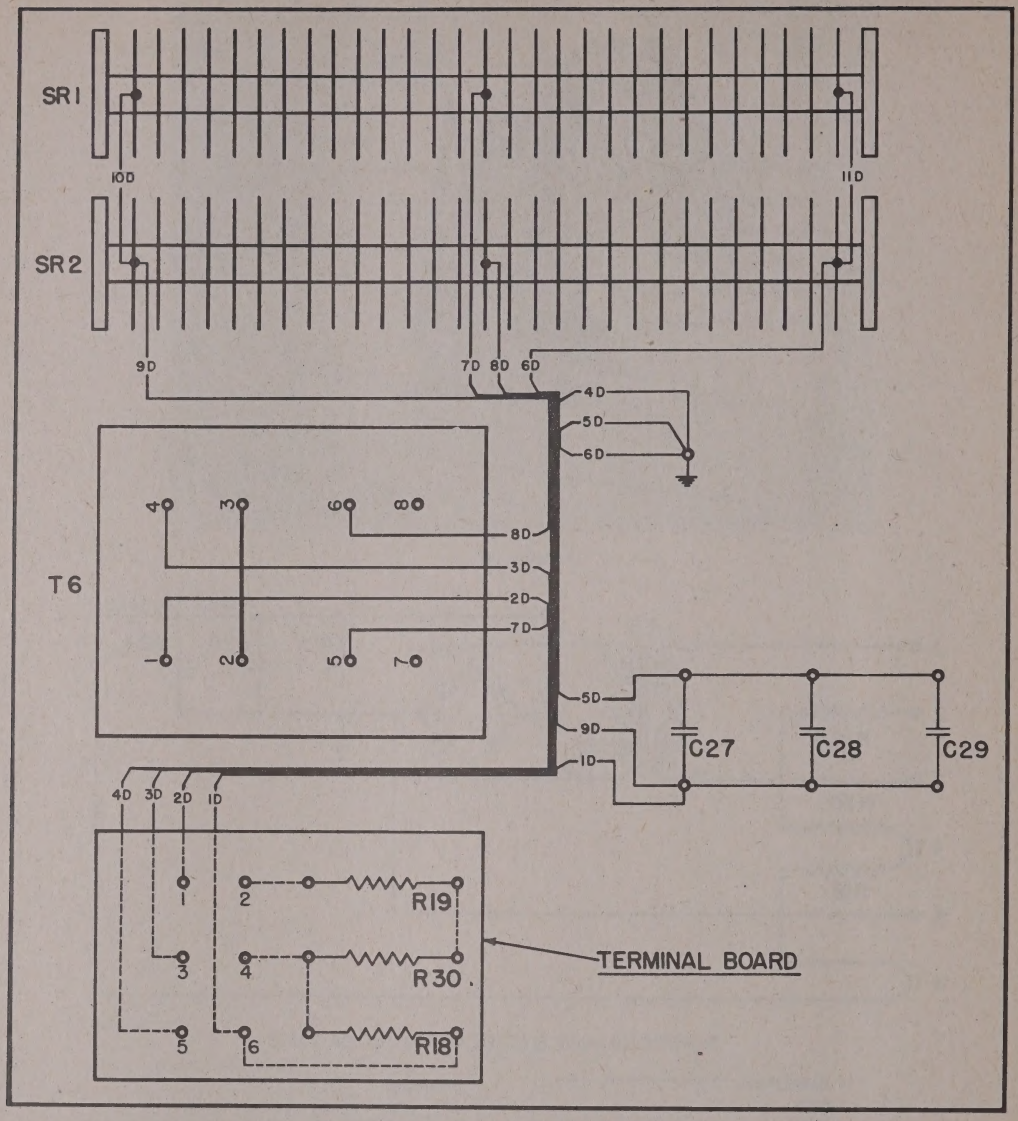
TRANSFORMER

T6 — Relay rectifier (pri. 115-230 v; sec. 100-120-140 v)

Figure 98

Figure 97. *Relay and bias rectifier chassis, top and side view.*

Figure 98. *Relay and bias rectifier chassis, schematic diagram.*



RELAY RECTIFIER TRANSFORMER T6,
IS CONNECTED FOR 230 VOLT OPERATION

TL 15541

Figure 99. Relay and bias rectifier, wiring diagram.

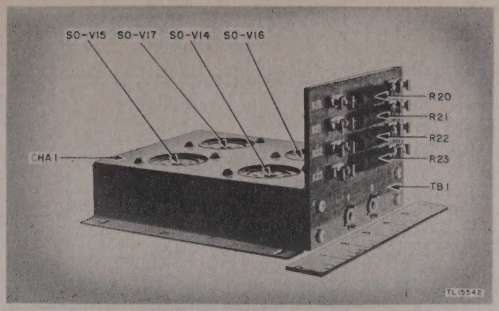


Figure 100

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

RESISTORS

R20	Regulator tube V14 equalizer (500 ohms, 2 w)
R21	Regulator tube V15 equalizer (500 ohms, 2 w)
R22	Regulator tube V16 equalizer (500 ohms, 2 w)
R23	Regulator tube V17 equalizer (500 ohms, 2 w)

TUBES

V14, V15, V16, V17	Bias voltage regulator

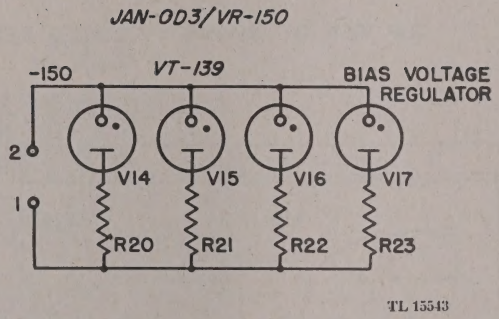


Figure 101

Figure 100. ***Bias voltage regulator tube chassis, front and side view.***

Figure 101. ***Bias voltage regulator chassis, schematic diagram.***

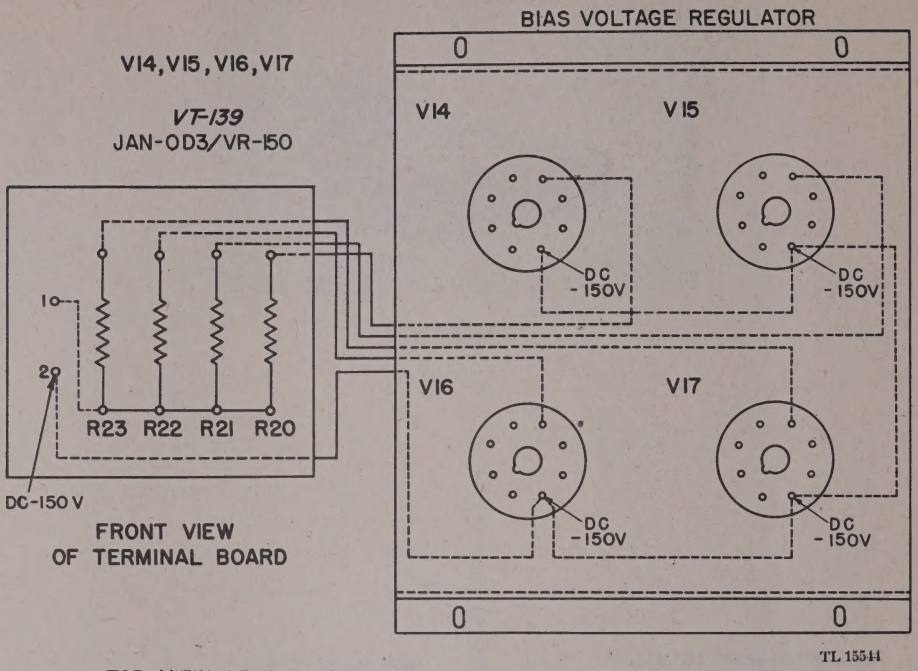


Figure 102

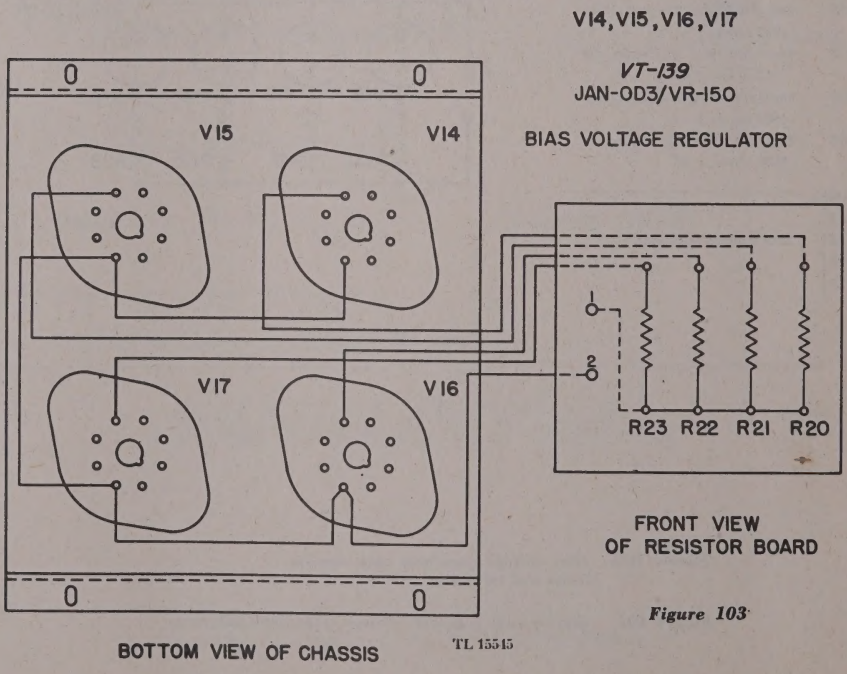


Figure 103

Figure 102. Bias voltage regulator chassis, tube socket layout diagram.
Figure 103. Bias voltage regulator chassis, wiring diagram.

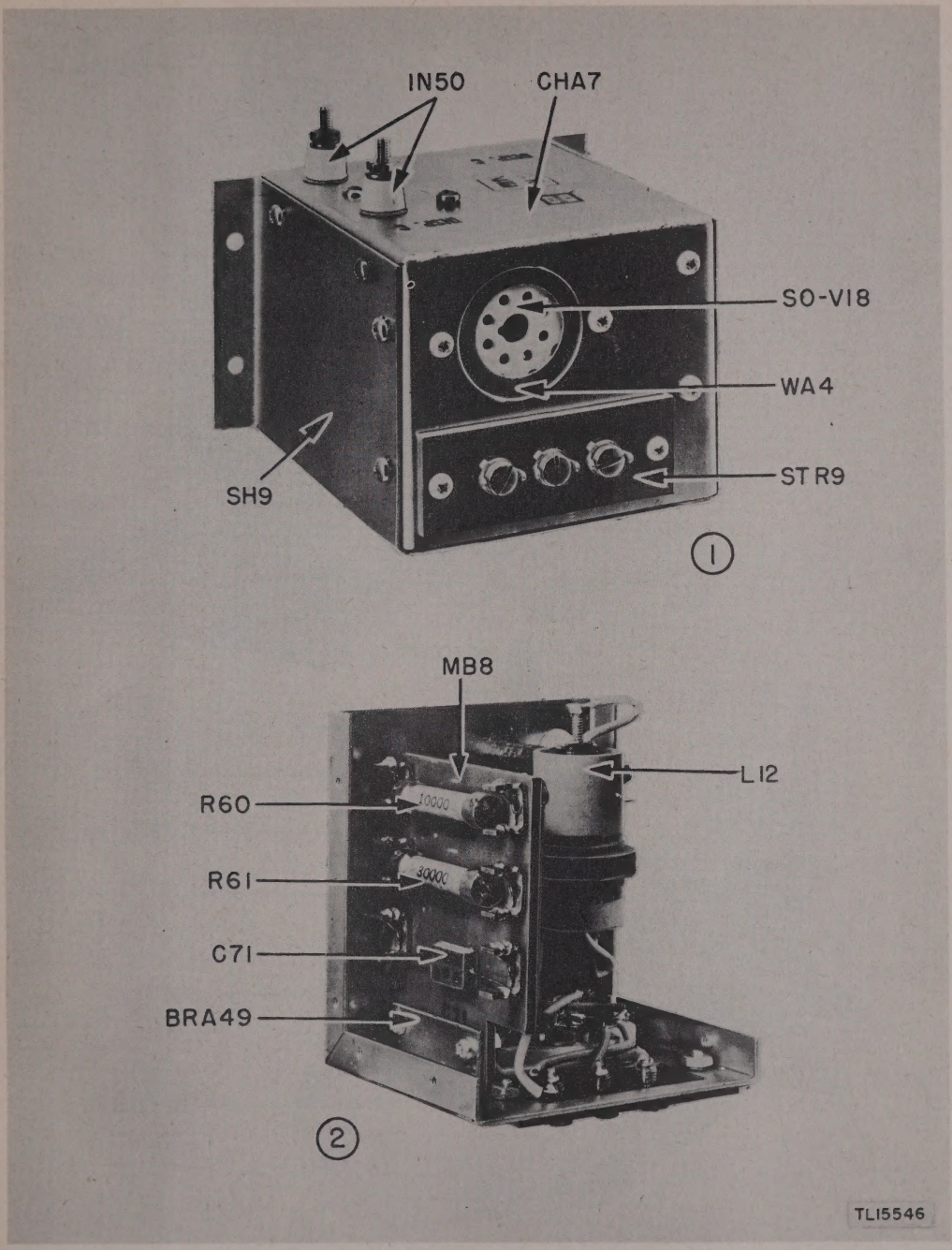


Figure 104. Link circuit meter rectifier:
① Outside view; ② Inside view.

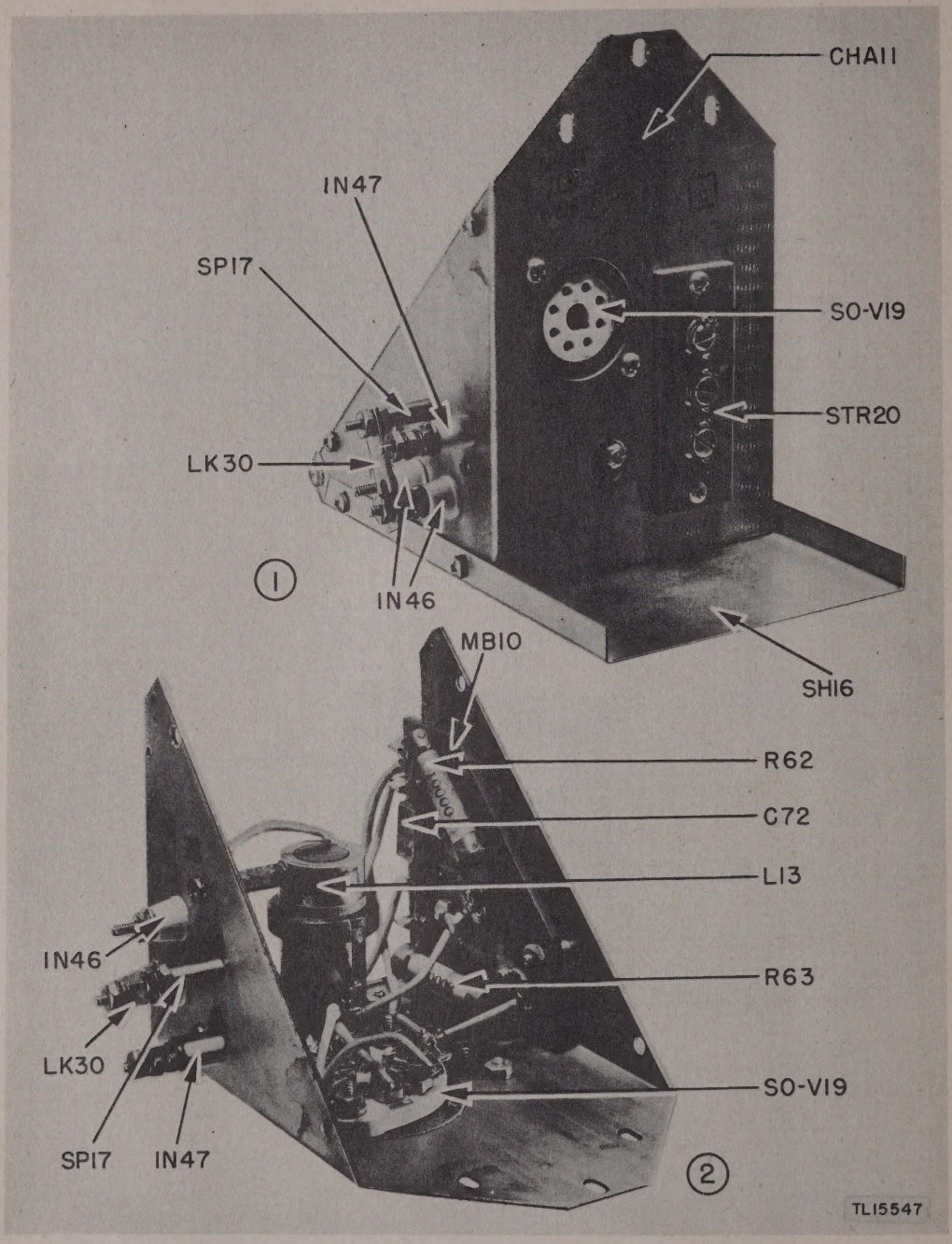


Figure 105. Left meter rectifier: (1) Outside view; (2) Inside view.

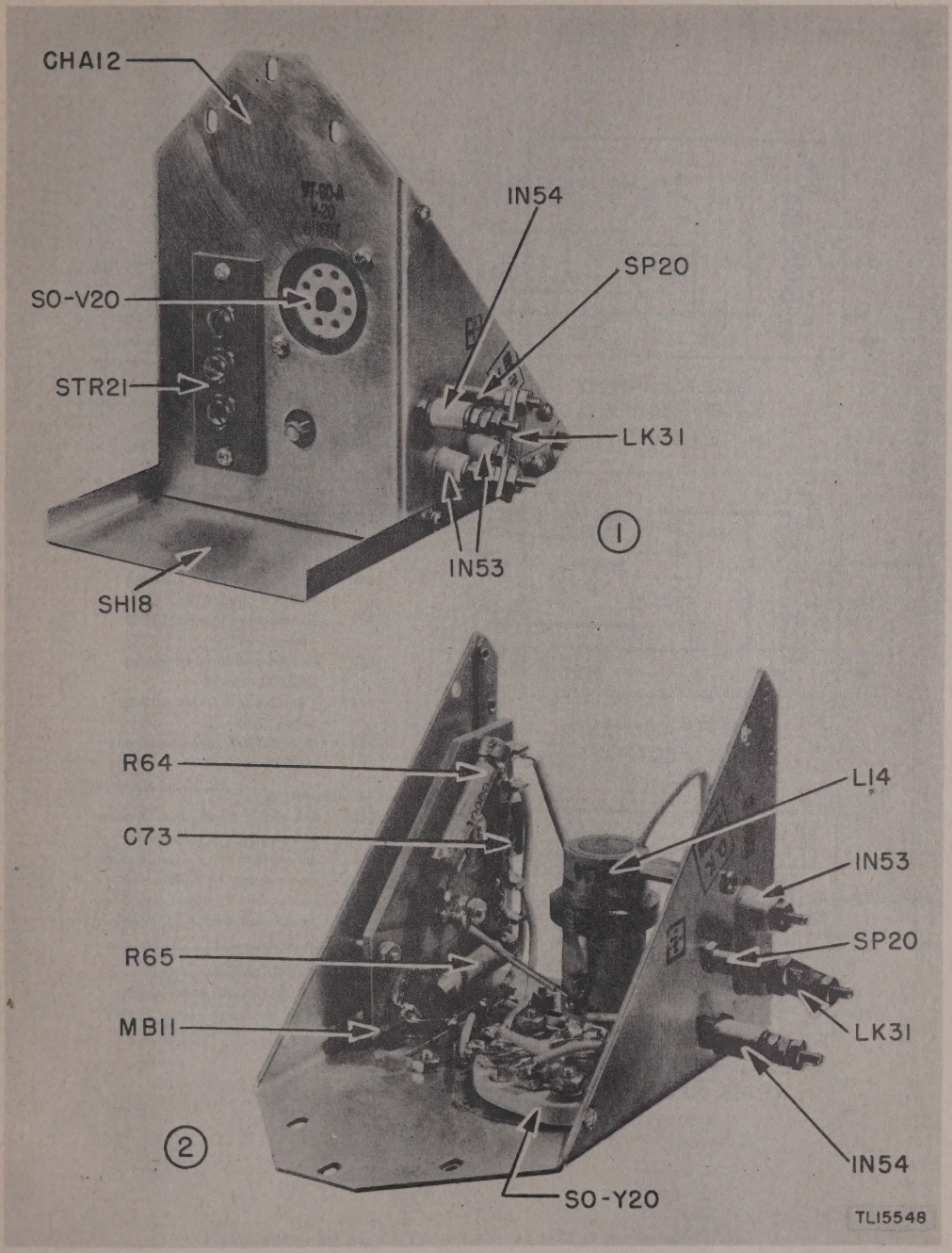
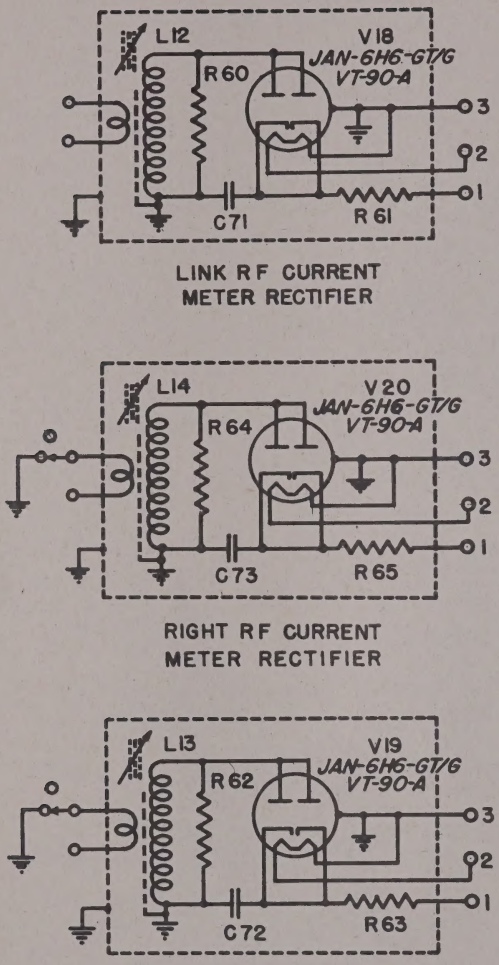


Figure 106. Right meter rectifier:
① Outside view; ② Inside view.



FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C71	Link circuit meter rectifier bypass (500 mmfd, 500 v d-c working)
C72	Left goniometer secondary meter rectifier bypass (500 mmfd, 500 v d-c working)
C73	Right goniometer secondary meter rectifier bypass (500 mmfd, 500 v d-c working)

RESISTORS

R60	Transformer L12 load (10,000 ohms, 2 w)
R61	Link circuit current metering (30,000 ohms, 2 w)
R62	Transformer L13 load (10,000 ohms, 2 w)
R63	Left antenna current metering (80,000 ohms, 2 w)
R64	Transformer L14 load (10,000 ohms, 2 w)
R65	Right antenna current metering (80,000 ohms, 2 w)

TRANSFORMERS

L12	Link circuit current (pri. 5 microhenries; sec. 13 millihenries)
L13	Left antenna current (pri. 5 microhenries; sec. 13 millihenries)
L14	Right antenna current (pri. 5 microhenries; sec. 13 millihenries)

TUBES

V18	Link circuit meter rectifier
V19	Left goniometer meter rectifier
V20	Right goniometer meter rectifier

Figure 107. R-f current meter rectifiers, schematic diagram.

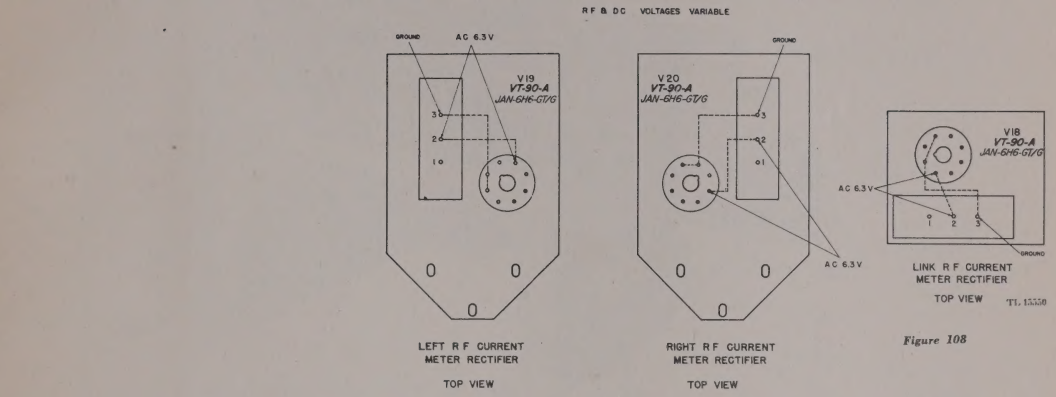


Figure 108

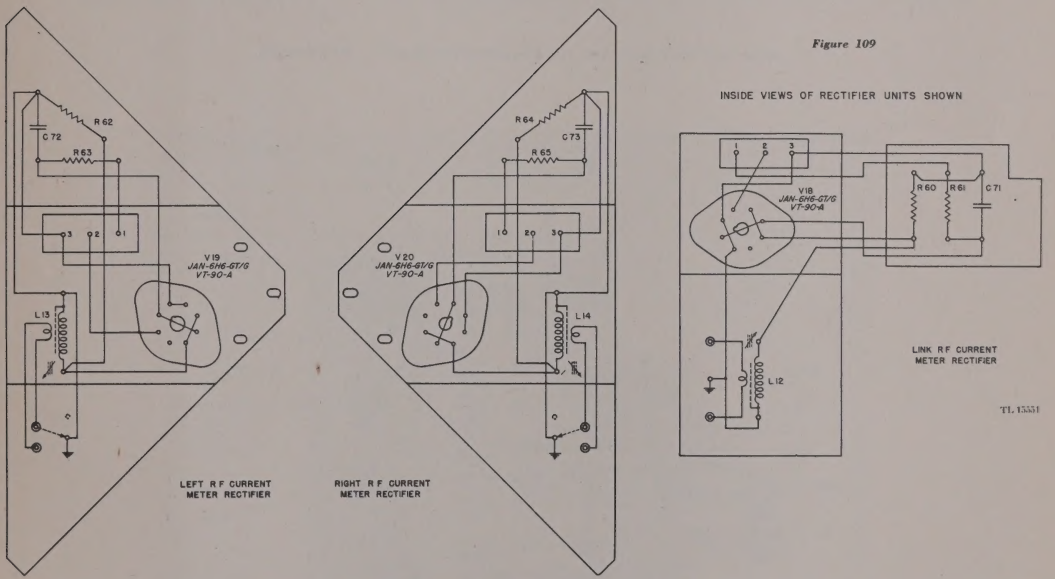


Figure 109

Figure 108. ***R-f current meter rectifiers, tube socket layout diagram.***

Figure 109. ***R-f current meter rectifiers, wiring diagram.***

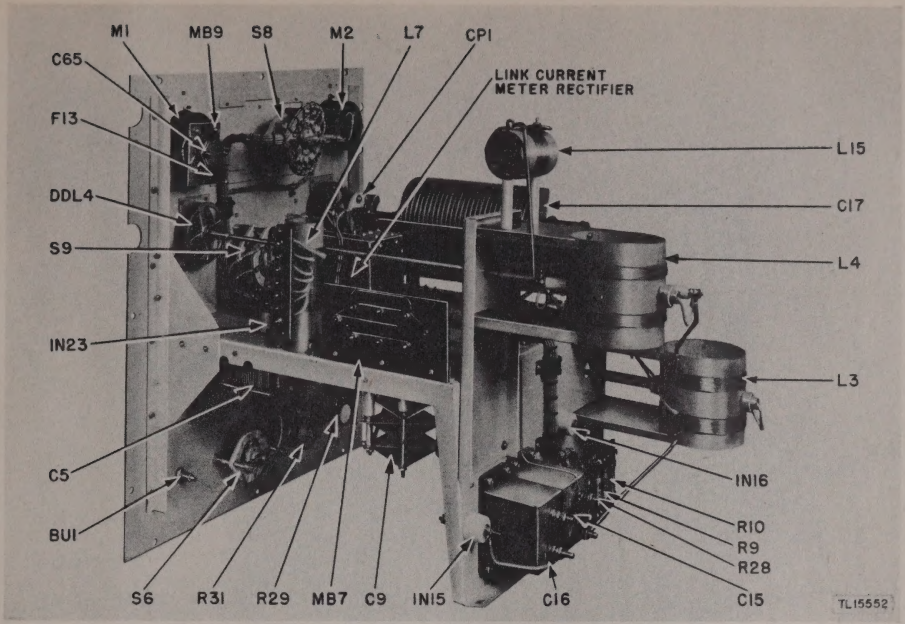


Figure 110. Meter and control unit, rear and right side view.

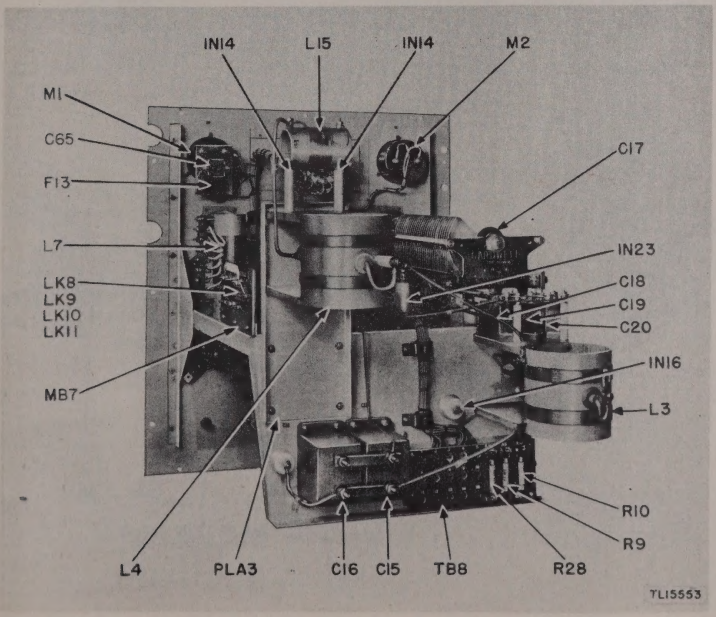


Figure 111. Meter and control unit, rear view.

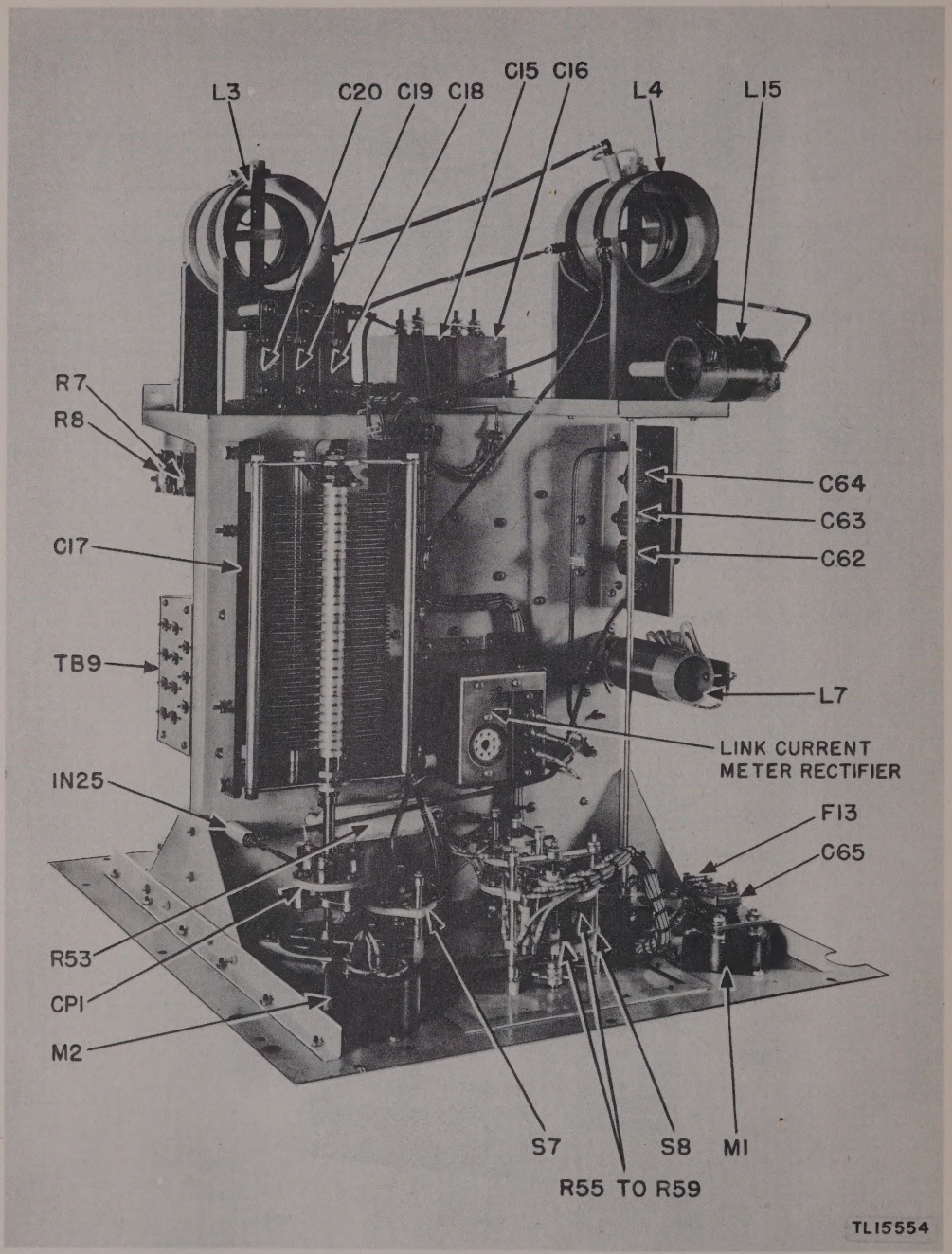


Figure 112. Meter and control unit, top and left side view.

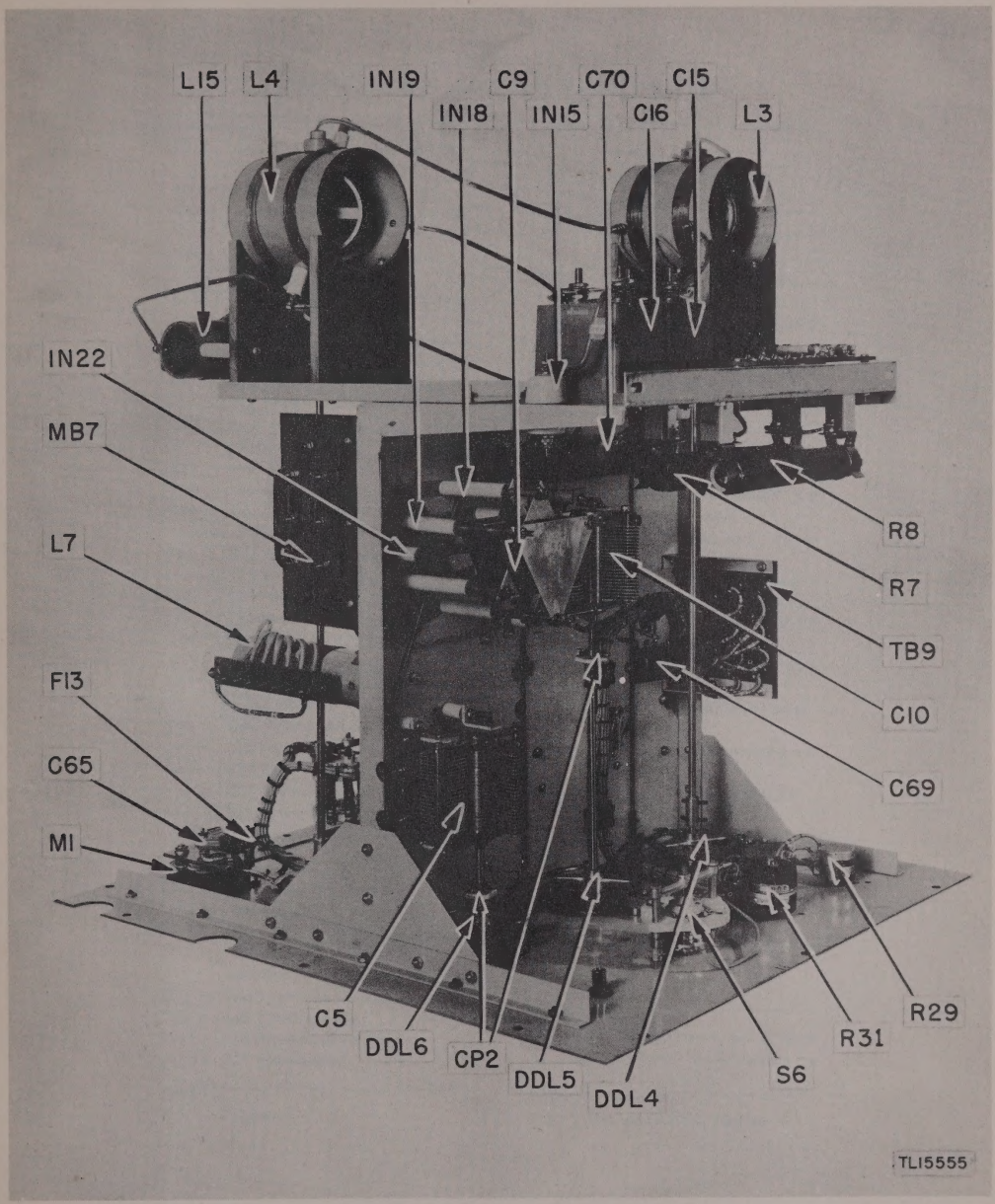


Figure 113. Meter and control unit, bottom and right side view.

FUNCTIONS AND ELECTRICAL VALUES OF PARTS

CAPACITORS

C5	Crystal oscillator tuning (40-1,050 mmfd, variable)
C9	P-a neutralization (16 mmfd)
C10	Intermediate p-a tuning (40-1,050 mmfd, variable)
C11	P-a grid padding (100 mmfd, 3,000 rms test)
C15	P-a tank (0.001 mfd, 8,000 rms test)
C16	P-a tank (0.001 mfd, 8.000 rms test)
C17	Link circuit tuning (1,020 mmfd, variable)
C18	Link circuit tuning (500 mmfd, 5,000 rms test)
C19	Link circuit tuning (0.001 mfd, 5,000 rms test)
C20	Link circuit tuning (0.001 mfd, 5,000 rms test)
C62	Quarter-phasing (0.002 mfd, 1,200 v d-c working)
C63	Quarter-phasing (0.004 mfd, 1,200 v d-c working)
C64	Quarter-phasing (0.008 mfd, 1,200 v d-c working)
C65	Meter M1 bypass (0.01 mfd, 600 v d-c working)
C69	Tone filter (0.05 mfd, 300 v d-c working)
C70	Modulation meter M2 blocking (0.1 mfd, 2,000 v d-c working)
C71	Link circuit meter rectifier bypass (500 mmfd, 500 v d-c working)

COILS

L3	P-a plate variometer (90-290 microhenries)
L4	Link circuit coupling variometer (pri. 23.5 microhenries; sec. 185 microhenries)
L7	Quarter-phasing (88 microhenries)
L12	Link circuit current
L15	Link circuit fixed coupler (30 microhenries)

FUSE

F13	D-c meter

METERS

M1	D-c meter (0-1 ma)
M2	A-c meter (0-150 v)

RESISTORS

R7	Modulation metering (50,000 ohm, 60 w)
R8	Modulation metering (50,000 ohms, 60 w)
R9	Auxiliary plate rectifier meterir (500,000 ohms, 2 w)
R10	Auxiliary plate rectifier meterir (500,000 ohms, 2 w)
R28	Relay rectifier metering (250,0C ohms, 2 w)
R29	Voice gain control (50,000 ohm dual potentiometer)
R31	Tone gain control (30,000 ohm dual potentiometer)
R53	Link circuit tuning load (10 ohm: 40 w)
R55	Crystal oscillator plate meterin (50 ohms, 2 w)
R56	Intermediate p-a plate meterin (10 ohms, 2 w)
R57	P-a cathode metering (5 ohms 2 w)
R58	Modulator cathode metering (5 ohms, 2 w)
R59	Main plate rectifier metering (63 ohms, 2 w)
R60	Transformer L12 load (10,000 ohms, 2 w)
R61	Link circuit current metering (30,000 ohms, 2 w)

SWITCHES

S6	Tone frequency
S7	Link tuning
S9	A-c meter
S8	D-C meter

TRANSFORMERS

L12	Link circuit current (pri. 5 micro-henries; sec. 13 millihenries)

TUBES

V18	Link circuit meter rectifier

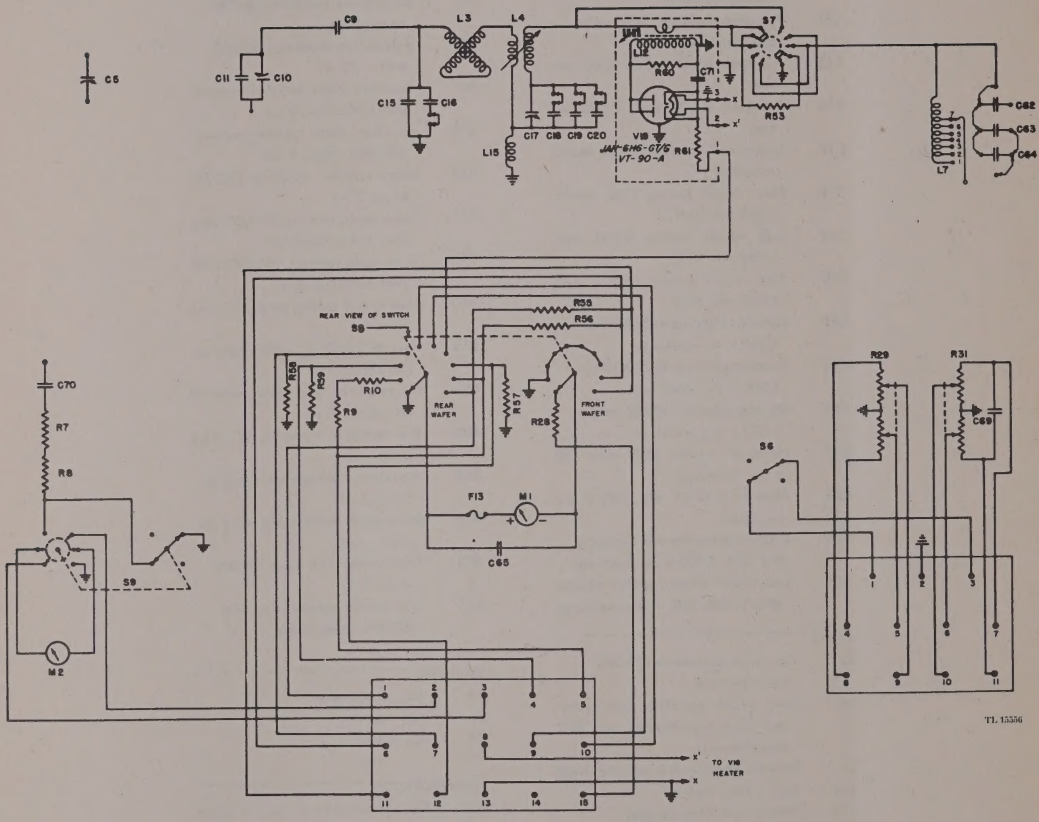


Figure 114. Meter and control unit, schematic diagram.

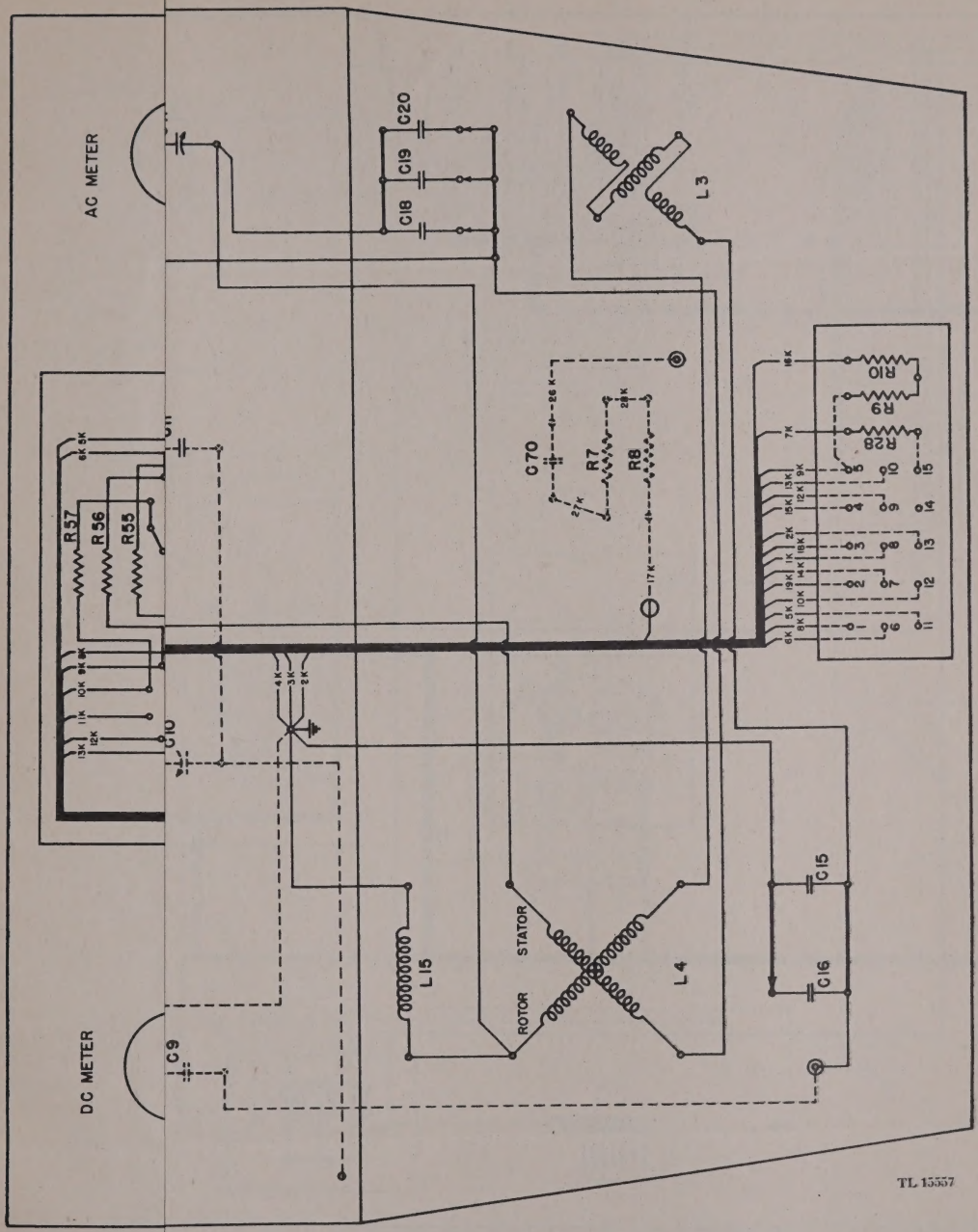


Figure 115. Meter and control unit, wiring diagram.

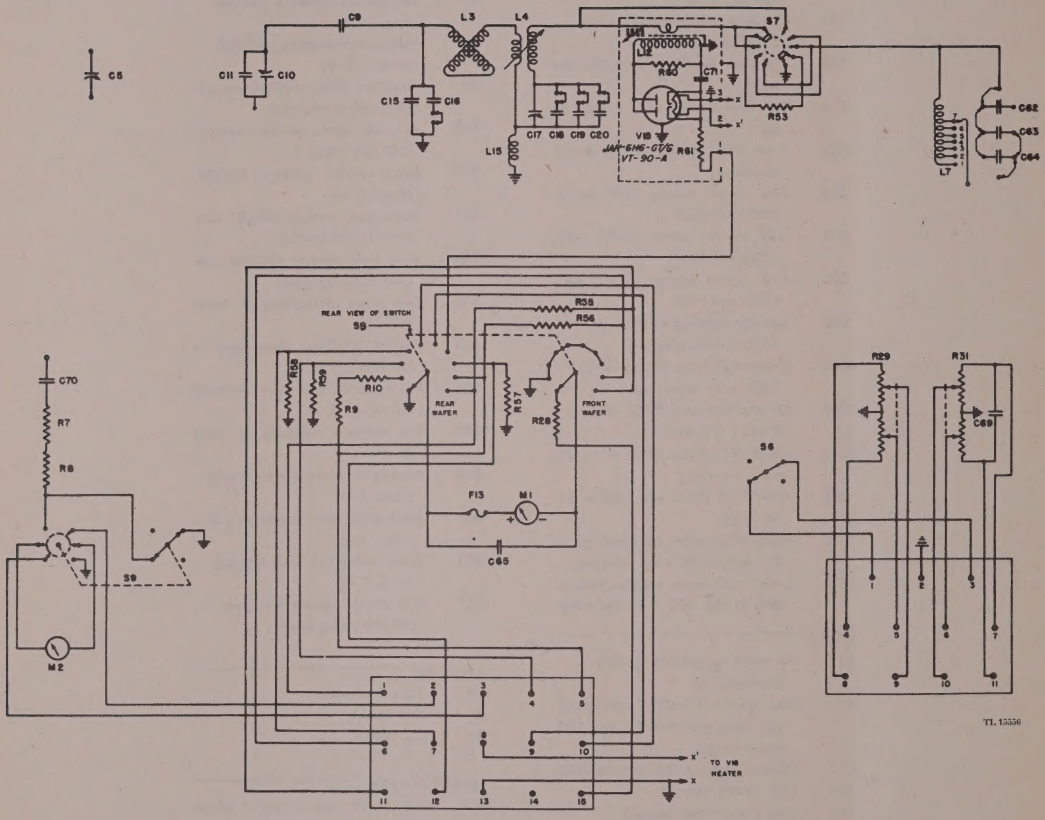


Figure 114. Meter and control unit, schematic diagram.

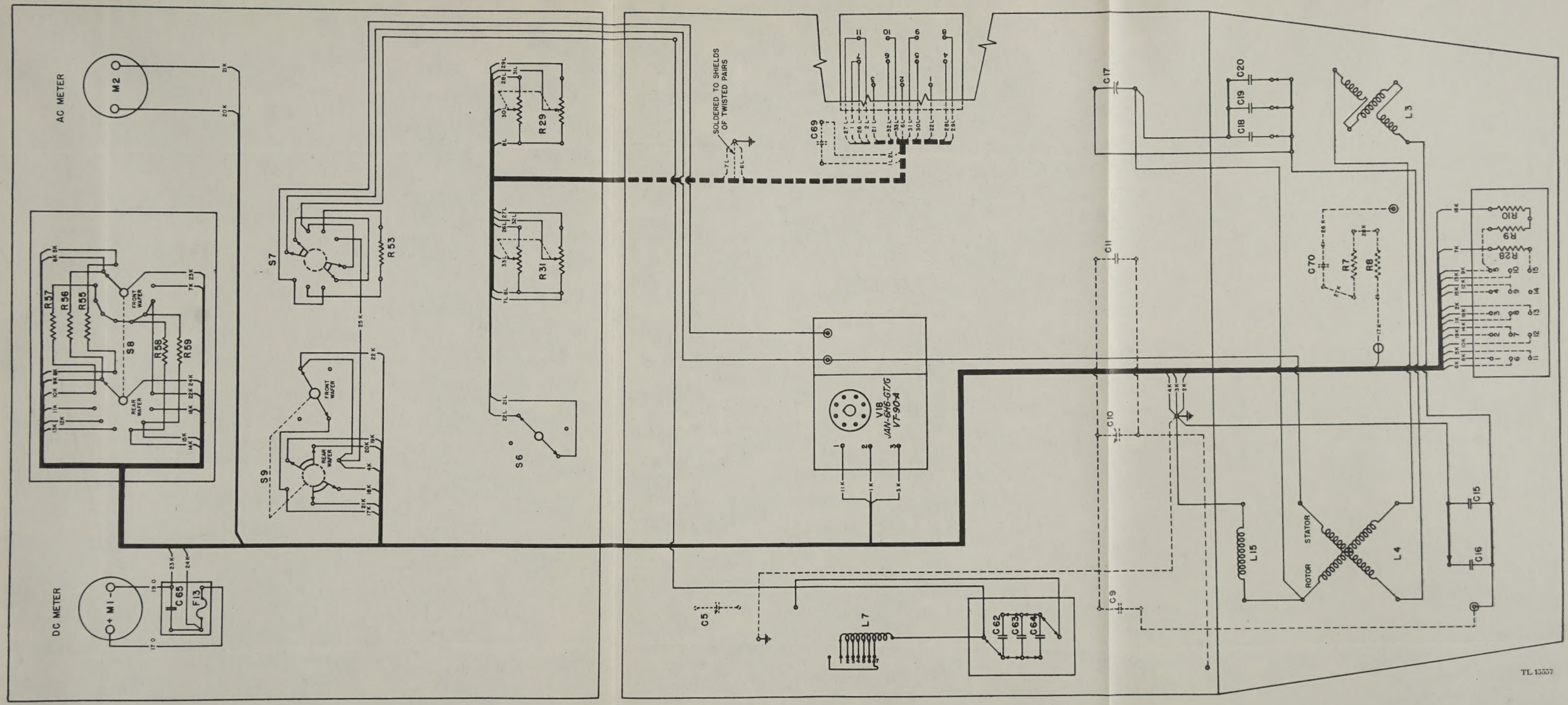
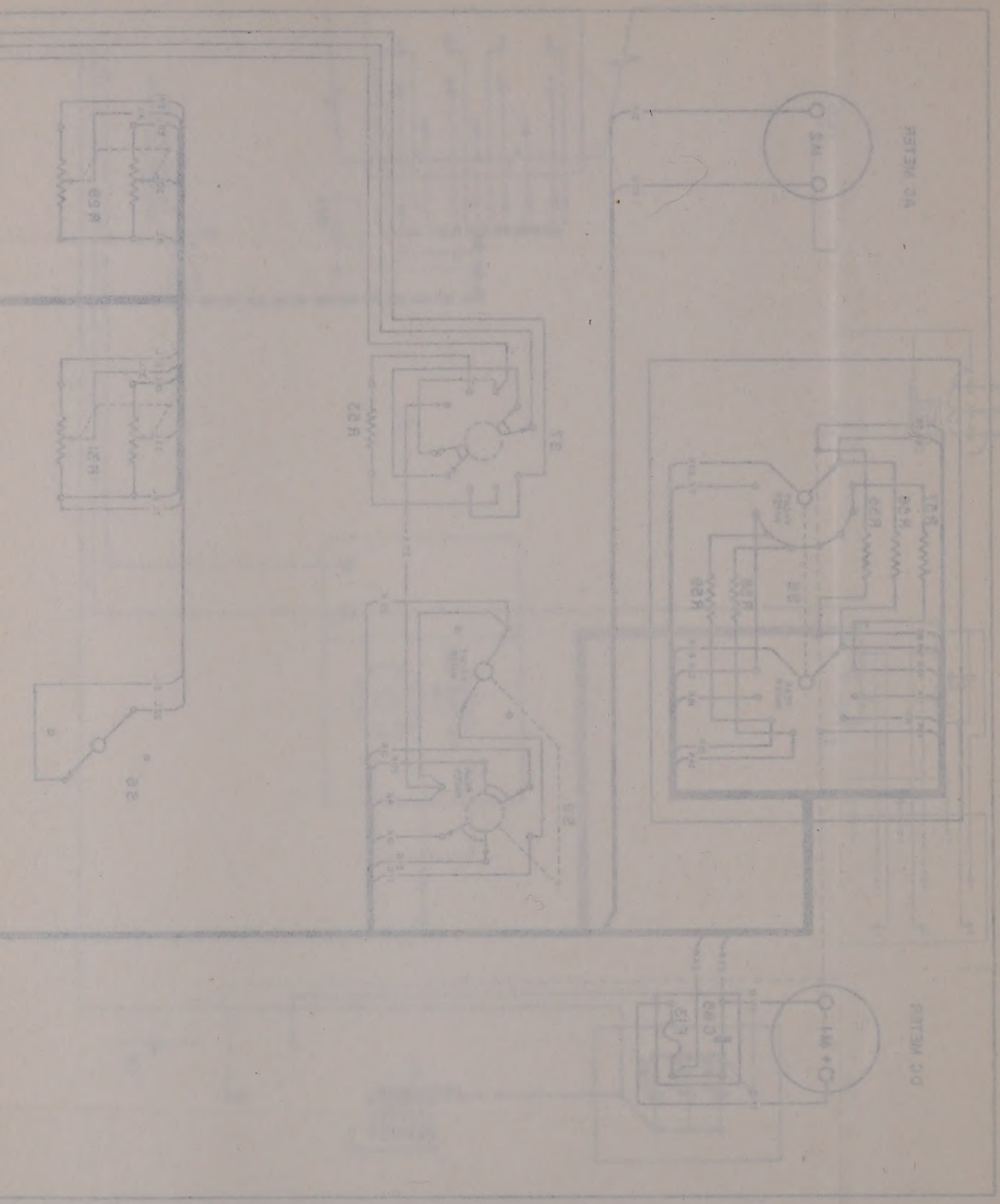


Figure 115. Meter and control unit, wiring diagram.



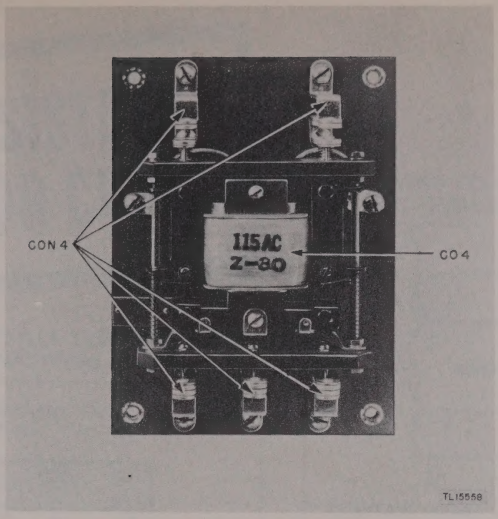


Figure 116. Quarter-phasing relay.

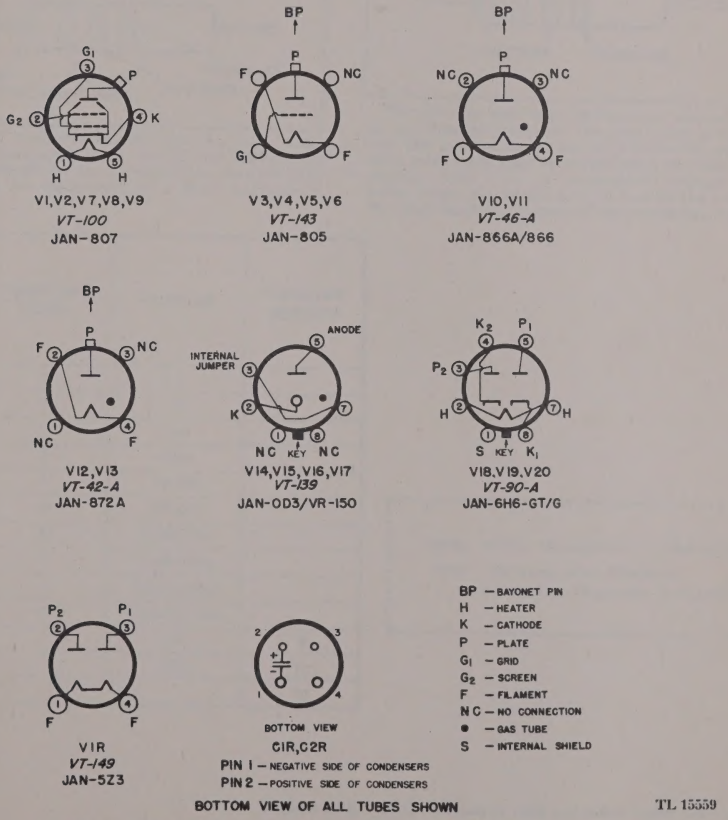
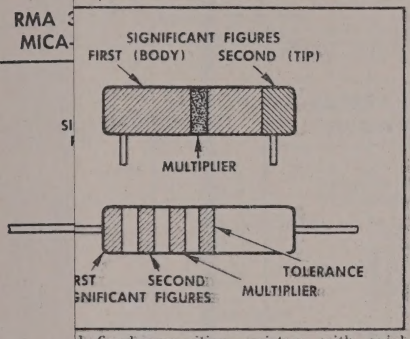


Figure 117. Tube and capacitor base pin designations.

CA RESISTOR CO LOR CODES

RMA COLOR CODE FOR ED COMPOSITION RESISTORS

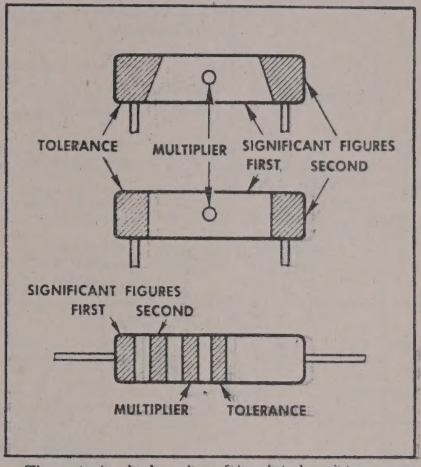
RMA 3 MICA-



d fixed composition resistors with axial designated by a natural tan background insulated fixed composition resistors with s are designated by a black background

Capacitors rating of 500

AWS COLOR CODE FOR FIXED COMPOSITION RESISTORS



The exterior body color of insulated resistors may be any color except black. The usual color is natural tan. The exterior body color of uninsulated resistors with axial leads may be either black or white. The exterior body color of uninsulated resistors with radial leads may be black or it may be the color of the first significant figure of the resistance value.

COLOR	SI	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE (PERCENT)
BLACK		0	1	
BROWN		1	10	
RED		2	100	
ORANGE		3	1000	
YELLOW		4	10,000	
GREEN		5	100,000	
BLUE		6	1,000,000	
VIOLET		7	10,000,000	
GRAY		8	100,000,000	
WHITE		9	1,000,000,000	
GOLD			0.1	5
SILVER			0.01	10
NO COLOR				20

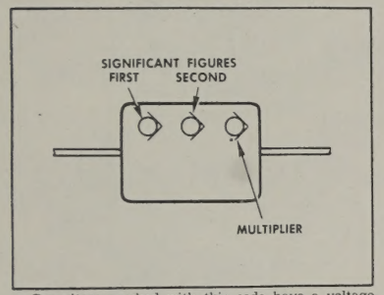
RMA: *Radio Manufacturers Association*
AWS: *American War Standard (American Standards Association)*

TL 13418

Figure 118. R.M.A. resistor and capacitor color code charts.

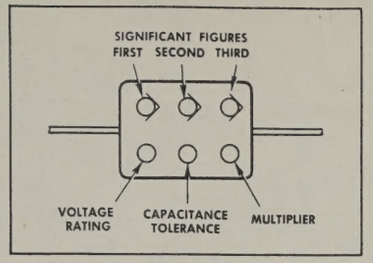
CAPACITOR COLOR CODES

RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

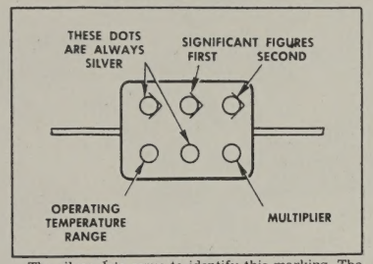


Capacitors marked with this code have a voltage rating of 500 volts.

RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

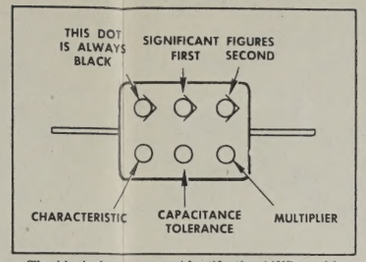


AWS 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



The silver dots serve to identify this marking. The sixth dot shows whether the capacitor has a maximum operating temperature of 167°F (black) or 185°F (brown).

AWS 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

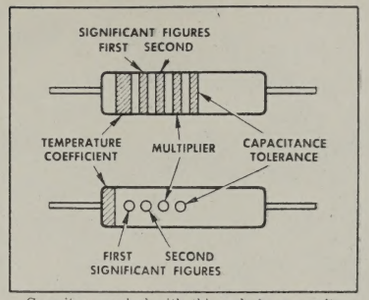


The black dot serves to identify the AWS marking. Capacitors marked with this code are rated at 500 volts, except the following. AWS type CM35 capacitors with capacitances of 6,800, 7,500, and 8,200 micromicrofarads, and AWS type CM40 capacitors with capacitances of 9,100 and 10,000 micromicrofarads are rated at 300 volts.

RMA: *Radio Manufacturers Association*
AWS: *American War Standard (American Standards Association)*

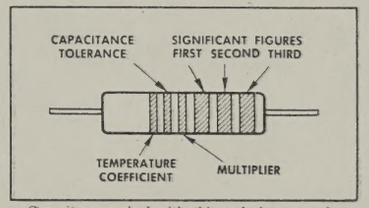
NOTE: These color codes give all capacitances in *micromicrofarads*.

AWS COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



Capacitors marked with this code have a voltage rating of 500 volts.

RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



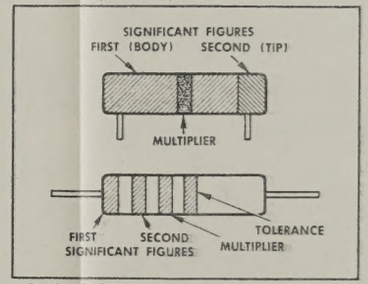
Capacitors marked with this code have a voltage rating of 500 volts.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER: RMA MICA- AND CERAMIC-DIELECTRIC AWS MICA- AND PAPER-DIELECTRIC	MULTIPLIER: AWS CERAMIC-DIELECTRIC	VOLTAGE RATING (VOLTS)	CHARACTERISTIC (AWS MICA-DIELECTRIC)	CAPACITANCE TOLERANCE: RMA & AWS MICA- AND PAPER-DIELECTRIC (PERCENT)	CAPACITANCE TOLERANCE: RMA CERAMIC-DIELECTRIC (PERCENT)	CAPACITANCE TOLERANCE: AWS CERAMIC-DIELECTRIC GREATER THAN 10 MMF (PERCENT)	CAPACITANCE TOLERANCE: AWS CERAMIC-DIELECTRIC LESS THAN 10 MMF (MMF)	TEMPERATURE COEFFICIENT OF CAPACITANCE x10⁻⁶ MMF/MMF/°C
BLACK	0	1	1		A	20	20	20	2.0	0
BROWN	1	10	10	100	B	1	1	1		− 30
RED	2	100	100	200	C	2	2	2		− 80
ORANGE	3	1000	1000	300	D	3	3	2.5	0.25	−150
YELLOW	4	10,000		400	E	4	4			−220
GREEN	5	100,000		500	F	5	5	5	0.5	−330
BLUE	6	1,000,000		600	G	6	6			−470
VIOLET	7	10,000,000		700		7	7			−750
GRAY	8	100,000,000	0.01	800		8	2.5			+ 30
WHITE	9	1,000,000,000	0.1	900		9	10	10	1.0	Not specified
GOLD		0.1		1000		5				
SILVER		0.01		2000		10				
NO COLOR				500		20				

TL 13417

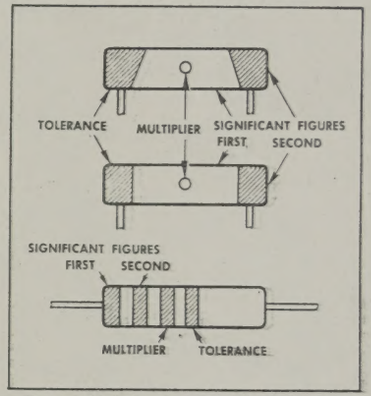
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS



Insulated fixed composition resistors with axial leads are designated by a natural tan background color. Non-insulated fixed composition resistors with axial leads are designated by a black background color.

AWS COLOR CODE FOR FIXED COMPOSITION RESISTORS



The exterior body color of insulated resistors may be any color except black. The usual color is natural tan. The exterior body color of uninsulated resistors with axial leads may be either black or white. The exterior body color of uninsulated resistors with radial leads may be black or it may be the color of the first significant figure of the resistance value.

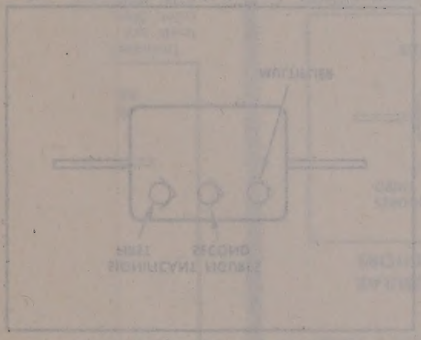
COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	
RED	2	100	
ORANGE	3	1000	
YELLOW	4	10,000	
GREEN	5	100,000	
BLUE	6	1,000,000	
VIOLET	7	10,000,000	
GRAY	8	100,000,000	
WHITE	9	1,000,000,000	
GOLD		0.1	5
SILVER		0.01	10
NO COLOR			20

RMA: *Radio Manufacturers Association*
AWS: *American War Standard (American Standards Association)*

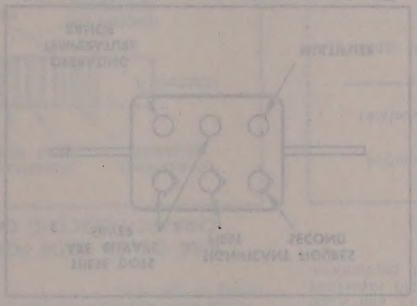
TL 13418

Figure 118. R.M.A. resistor and capacitor color code charts.

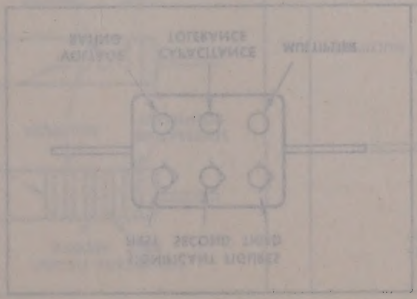
COLOR	SIGNIFICANT FIGURE	MICA-DIELECTRIC CAPACITORS: RMA 3-DOT COLOR CODE FOR CAPACITANCE IN MMFD	CERAMIC-DIELECTRIC CAPACITORS: RMA 3-DOT COLOR CODE FOR CAPACITANCE IN MMFD	PAPER-DIELECTRIC CAPACITORS: RMA 3-DOT COLOR CODE FOR CAPACITANCE IN MMFD	DIELECTRIC STRENGTH	TOLERANCE
		MULTIPLIER				
BLACK	0	1	1		A	20
BROWN	1	10	10	100	B	1
RED	2	100	100	300	C	2
ORANGE	3	1000	1000	500	D	3
YELLOW	4	10,000		700	E	4
GREEN	5	100,000		900	F	5
BLUE	6	1,000,000		1000	G	6
VIOLET	7	10,000,000		1200		7
GRAY	8	100,000,000	0.01	1500		8
WHITE	9	1,000,000,000	0.1	1800		9
GOLD		0.1		2000		5
SILVER		0.01		2500		10
NO COLOR				3000		20



MICA-DIELECTRIC CAPACITORS
RMA 3-DOT COLOR CODE FOR



PAPER-DIELECTRIC CAPACITORS
RMA 3-DOT COLOR CODE FOR



MICA-DIELECTRIC CAPACITORS
RMA 3-DOT COLOR CODE FOR

COLOR CODES
CAPACITOR